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Guideline for Design, Installation Operation, and Quality Assurance for Dry Deposition Monitoring Networks

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This manual provides basic, practical, field-tested guidance on the installation, operation, maintenance, calibration, and auditing of dry deposition measurement systems. The information provided is based primarily on EPA's experience in installing, operating, maintaining, and auditing the National Dry Deposition Network. It has been supplemented with information gathered from personnel involved in other acid deposition and some non-acid deposition monitoring networks, and by a review of present research and development efforts. The information presented is current and correct as of August 1988. The manual is a succinct presentation of the essential information needed from the time monitoring is planned until the monitoring project and the data assessment are completed. It is intended for both experienced and inexperienced monitoring personnel. Each section of the manual first describes the activities covered by the topic area, then it describes the quality control activities that apply, and finally discusses the quality assurance activities that can be done to ensure the quality control activities are being done.

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GUIDELINE FOR DESIGN, INSTALLATION, OPERATION, AND QUALITY ASSURANCE FOR DRY DEPOSITION MONITORING NETWORKS

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1.0 INTRODUCTION

In response to public concern over the possible adverse effects of acidic deposition on natural environments, materials, wildlife, and public health, Congress passed the Acid Precipitation Act of 1980 (P.L. 96-294 Title VII). This act resulted in an explosion of monitoring activity in the area of acid deposition. Numerous research projects, sampling networks, and studies, for example, the National Dry Deposition Network (NDDN), the Mountain Cloud Chemistry Program (MCCP), the Forest Response Program (FRP), the Operation Evaluation Network (OEN), the Acid Model Operational Diagnostic Evaluation Study (ACID MODES), and the National Atmospheric Deposition Program/National Trends Network (NADP/NTN), were initiated to monitor and study acid deposition. Because it was a new area of research, many of the organizations carrying out these projects had little experience in measuring acid gases, acid particulates, and meteorological parameters under the conditions encountered when measuring acid deposition. Not surprisingly, most of these projects are measuring many of the same parameters.

This manual provides basic, practical, field-tested guidance on the installation, operation, maintenance, calibration, and auditing of dry deposition measurement systems. The information provided is based primarily on EPA's experience in installing, operating, maintaining, and auditing the National Dry Deposition Network. It has been supplemented with information gathered from personnel involved in other acid deposition and some non-acid deposition monitoring networks, and by a review of present research and development efforts. The information presented is current and correct as of August 1988. However, because dry deposition monitoring is a relatively new area of research, the methodology is continually being modified and improved in the areas of data assessment, quality assurance, and measurement. Thus, we expect to update this guidance document in approximately three years as our knowledge of acid deposition improves. In the interim, it is hoped that the widespread use of the guidance in this manual will improve the comparability of measurements across all acid deposition monitoring projects. Users are encouraged to submit their comments concerning additions, deletions, and other modifications that will improve the usefulness of this manual. This information can be sent to the author.

The manual is a succinct presentation of the essential information needed from the time monitoring is planned until the monitoring project and the data assessment are completed. It is intended for both experienced and inexperienced monitoring personnel and is divided into sections and appendices covering the following topics:

1. Monitoring Project Design and Implementation
2. Site Selection
3. Procurement and Testing of Materials and Equipment
4. Site Installation
5. Site Operations
6. Training
7. Laboratory Operations
8. Data Management

Each section of the manual is organized as follows. First, the activities that are covered by the topic area are described. Then, the types of quality control procedures that apply to these activities are described in detail. Finally, quality assurance procedures that can be used to assure that these quality control activities are being done are presented. Samples of practical, field-tested auditing procedures are described in detail in the appendices for illustrative purposes.

Although the document addresses dry deposition monitoring, the techniques and information presented should also prove helpful to those planning to establish other monitoring networks in such areas as global climate change, stratospheric ozone, and greenhouse affect assessment.

Other documents that might be useful to planners and provide additional detailed information about meteorological systems and wet deposition are listed below. The meteorological handbook is being revised.

1. Finkelstein, P.L., et. al. Quality Assurance Handbook for Air Pollution Measurement Systems: Vol. IV - Meteorological Measurements. U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA 600/4-82-060 (February 1983).

2. Topol, L.E., et. al. Operation and Maintenance Manual for Precipitation Measurement Systems. U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA 600/4-82-042b (July 1986).

3. Topol, L.E., et. al. Quality Assurance Manual for Precipitation Measurement Systems. U.S. Environmental Protection Agency, Research Triangle Park, NC. EPA 600/4-82-042a (January 1985).

2.0 MONITORING PROJECT DESIGN

Two factors that determine the manner and direction in which a monitoring project is developed are:

1. Project Objectives -- What is to be accomplished?
2. Quality Objectives -- How precise and accurate must the collected data be?

Once these objectives have been clearly defined, the project can be designed to ensure that these objectives are met.

The following considerations should be addressed during project design:

1. What is to be measured.
   - Pollutants (HNO_3, SO_2, NO_3, SO_4, etc.)
   - Parameters (wind speed, solar radiation, surface wetness, etc.)
   - Wet deposition (anions, cations, etc.)
2. How it will be measured.
   - Measurement methods (integrated sampler, continuous monitors, etc.)
   - Equipment needed (shelters, meteorological towers, ozone monitors, etc.)
   - Support required (laboratory, telephone, site operator, electric power, etc.)
3. Where it will be measured.
   - Site location (urban, rural, forest, etc.)
   - Site criteria (what constitutes a good site)
4. When it will be measured.
   - Event sampling
   - Daily sampling
   - Weekly sampling
   - Combination of above
   - Every 6th day sampling
5. How collected data will be handled.

- -- Data acquisition system (strip chart, computer, data logger, etc.)
- -- Data transport system (mail, modem, etc.)
- -- Data validation (what is acceptable data)
- -- Data storage (data base, logbook, etc.)

6. How data quality will be ensured.

   - -- Calibration frequency
   - -- Quality control procedures
   - -- Standard operating procedures (SOP's)
   - -- Collocated sites
   - -- Documentation
   - -- Data validation procedures
   - -- Development of a quality assurance project plan

7. How data quality will be assessed.

   - -- Quality auditing
     - -- Systems
     - -- Performance

Upon completion of the design stage, the monitoring project must be implemented and brought to full operational status. Activities usually associated with project implementation and operation are:

- -- Site selection (Section 3.0)
- -- Procurement, testing, and calibration of equipment and supplies (Section 4.0)
- -- Training (Section 7.0)
- -- Site installation (Section 5.0)
- -- Routine site operation (Section 6.0)

2.1 QA's Role in Project Design

Quality assurance (QA) must play a major role in project design. Failure to adequately address QA needs in all project areas at this stage could jeopardize the usefulness of the collected data.

QA activities usually included in project design are:

- -- Quality control
- -- Quality auditing
- -- Document control
- -- Procurement control
- -- Quality objectives
- -- Data validation

2.2 Summary

A monitoring project that has made QA an integral part of every project activity will be capable of producing a valid, defensible data base that meets the project's needs. Because the data is of known and documented quality, it can be used confidently by other user groups or projects.

3.0 SITE SELECTION

What constitutes a "good" dry deposition monitoring site? The answer to this question will be considerably different for researchers interested in forest decline and those interested in material effects. However, all researchers use the same basic concepts and procedures to develop project specific siting criteria and site selection processes.

3.1 Site Selection Criteria

The location and characteristics of a monitoring site have a major influence on overall data quality and utility. Therefore, the selection of dry deposition sites should be based on site selection criteria that assure the site's physical and chemical environment meet the needs of the monitoring project (e.g., NDDN, MCCP, model evaluation).

The following criteria are useful in evaluating the general acceptability of a proposed monitoring site:

1. Site accessibility. Year-round accessibility is an important consideration for long-term trends monitoring. This requirement frequently rules out a site that would otherwise be ideal.

2. Site stability. The stability of a site in terms of land use and ownership are important considerations for monitoring projects. This is especially true for long-term trends monitoring.

   a. Ownership - Sites that may not be available for a project's duration should be avoided. Moving sites during a project may adversely affect the data and usually entails additional costs.

   b. Land use - The land use around the site should be stable. A site located where land use is in a state of change might not provide data that is representative of the area as a whole.

3. Site utility requirements. Electric power is essential for most monitoring projects. Some projects require both power and telephone service. The difference in the cost of running a power line several miles to one site and a few yards to another site might be the deciding factor in choosing between two sites of otherwise equal desirability.

4. Regional representativeness. Regional representativeness refers to the overall similarity of the site to the area or region surrounding the site. Land use classification of the site's immediate surroundings should match the dominant regional land use. A regionally representative site should collect data reflective of the mean air quality of the region and should be

located so that positive and negative biases are avoided. To ensure representativeness, major sources of pollutants such as sulfur dioxide (SO_2) and nitrogen oxides (NO_x) that could bias the data should be avoided.

5. Immediate surroundings. Site-specific criteria (e.g., siting criteria which address a site's immediate surroundings) target local features that could bias sample quality and affect meteorological observations. Site-specific criteria for wet and dry deposition are very similar. However, the criteria for dry deposition monitoring tends to be more restrictive because nearby obstacles and contamination sources are likely to have a more pronounced effect on gas and particulate samples than on precipitation chemistry. Table 3-1 lists the site-specific criteria used in site selection for EPA's National Dry Deposition Network (NDDN).

Table 3-1. Site-Specific Criteria for Dry Deposition Monitoring

Potential interferent	Minimum distance from measurement apparatus
Large point source of SO_2 or NO_x	20 to 40 km
Major industrial complex	10 to 20 km
City, >50,000 population	40 km
City, 10,000 to 50,000 population	10 km
City, 5,000 to 10,000 population	5 km
Major highway, airport, or railyard	2 km
Secondary road, heavily traveled	500 m
Secondary road, lightly traveled	200 m
Feedlot operations	500 m
Intensive agricultural operations (including aerial spraying)	500 m
Limited agricultural operations	200 m
Large parking lot	200 m
Small parking lot	100 m
Tree line	50 m
Obstacle smaller than 3 m^3	6 m
Obstacle larger than 3 m^3	10 m

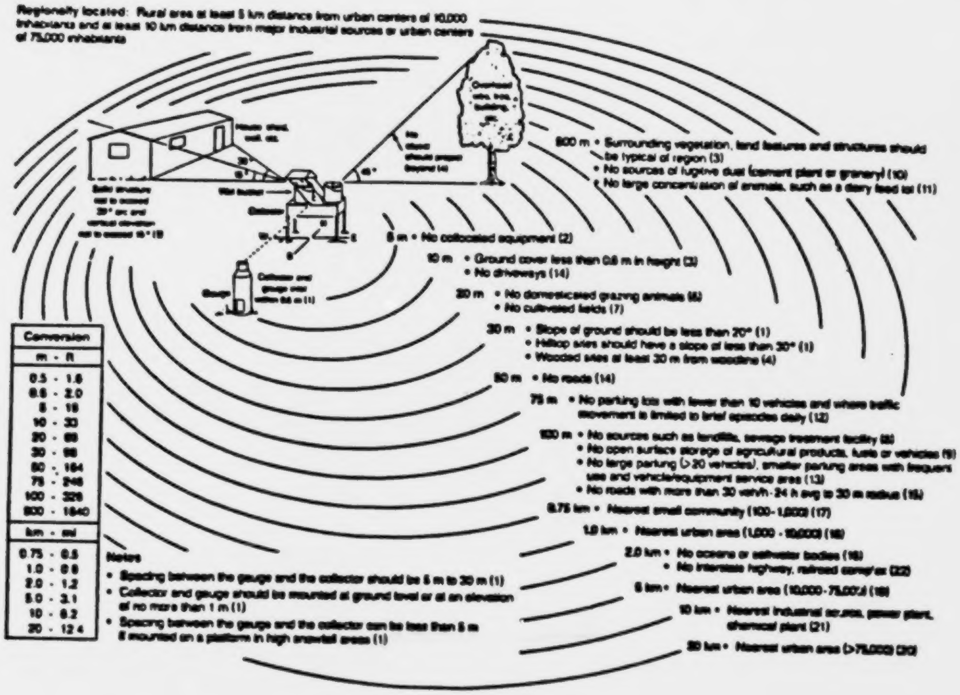
Note: m = meters
m^3 = cubic meters

Source: ESE, 1987

The siting criteria for regionally representative and urban influenced sites, taken from EPA prepared siting guidelines for wet deposition monitoring, are shown in Figure 3-1.

Siting guidelines developed for EPA for wet and dry deposition are reproduced in the appendices. Included are:

-- Siting Criteria for Dry Deposition Trends Monitoring Networks (Appendix A)


Regionally located: Rural area at least 5 km distance from urban centers of 10,000 inhabitants and at least 10 km distance from major industrial sources or urban centers of 75,000 inhabitants
House, shed, wall, etc.
Overhead wire, tree, building, etc.
45°
Wet bucket
Collector
Gauge
Collector and gauge mounted within 0.6 m (1)
500 m • Surrounding vegetation, land features and structures should be typical of region (3)
• No sources of fugitive dust (cement plant or granery) (10)
• No large concentration of animals, such as a dairy feed lot (11)
5 m • No collocated equipment (2)
10 m • Ground cover less than 0.6 m in height (3)
• No driveways (14)
20 m • No domesticated grazing animals (6)
• No cultivated fields (7)
30 m • Slope of ground should be less than 20° (1)
• Hilltop sites should have a slope of less than 30° (1)
• Wooded sites at least 30 m from woodline (4)
50 m • No roads (14)
75 m • No parking lots with fewer than 10 vehicles and where traffic movement is limited to brief episodes daily (12)
100 m • No sources such as landfills, sewage treatment facility (8)
• No open surface storage of agricultural products, fuels or vehicles (9)
• No large parking (>20 vehicles), smaller parking areas with frequent use and vehicle/equipment service area (13)
• No roads with more than 30 veh/h - 24 h avg to 30 m radius (15)
0.75 km • Nearest small community (100 - 1,000) (17)
1.0 km • Nearest urban area (1,000 - 10,000) (18)
2.0 km • No oceans or saltwater bodies (16)
• No interstate highway, railroad complex (22)
5 km • Nearest urban area (10,000 - 75,000) (19)
10 km • Nearest industrial source, power plant, chemical plant (21)
20 km • Nearest urban area (>75,000) (20)
Conversion
m - ft
0.5 - 1.6
0.6 - 2.0
5 - 16
10 - 33
20 - 66
30 - 98
50 - 164
75 - 246
100 - 328
500 - 1640
km - mi
0.75 - 0.5
1.0 - 0.6
2.0 - 1.2
5.0 - 3.1
10 - 6.2
20 - 12.4
Notes
• Spacing between the gauge and the collector should be 5 m to 30 m (1)
• Collector and gauge should be mounted at ground level or at an elevation of no more than 1 m (1)
• Spacing between the gauge and the collector can be less than 5 m if mounted on a platform in high snowfall areas (1)

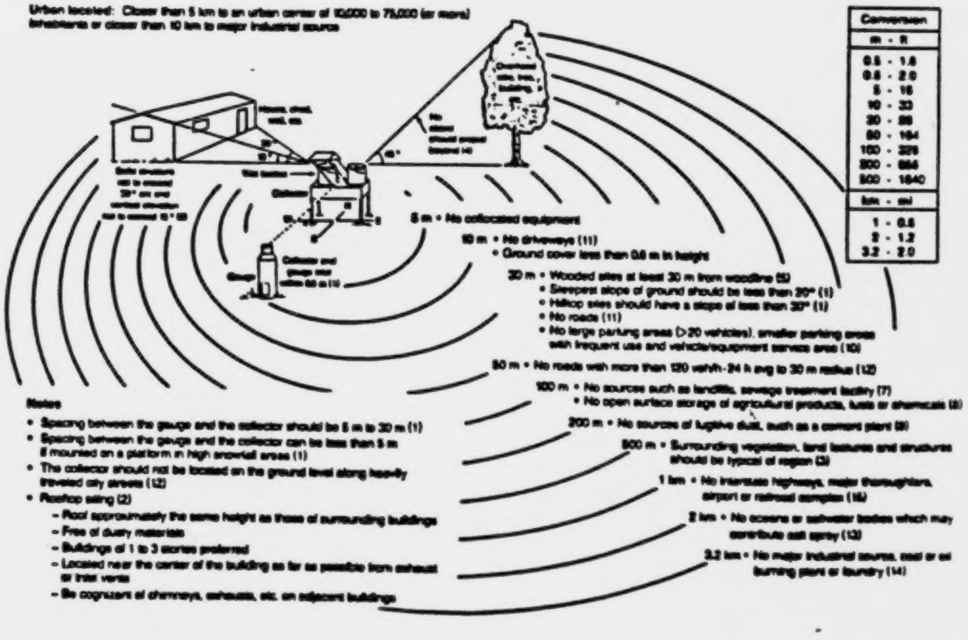

Urban located: Closer than 5 km to an urban center of 10,000 to 75,000 (or more) inhabitants or closer than 10 km to major industrial source
Wet bucket
Collector
Gauge
45°
5 m • No collocated equipment
10 m • No driveways (11)
• Ground cover less than 0.6 m in height
30 m • Wooded sites at least 30 m from woodline (5)
• Steepest slope of ground should be less than 20° (1)
• Hilltop sites should have a slope of less than 30° (1)
• No roads (11)
• No large parking areas (>20 vehicles), smaller parking areas with frequent use and vehicle/equipment service area (10)
50 m • No roads with more than 120 veh/h - 24 h avg to 30 m radius (12)
100 m • No sources such as landfills, sewage treatment facility (7)
• No open surface storage of agricultural products, fuels or chemicals (8)
200 m • No sources of fugitive dust, such as a cement plant (9)
500 m • Surrounding vegetation, land features and structures should be typical of region (3)
1 km • No interstate highways, major thoroughfares, airport or railroad complex (16)
2 km • No oceans or saltwater bodies which may contribute salt spray (13)
3.2 km • No major industrial source, coal or oil burning plant or foundry (14)
Conversion
m - ft
0.5 - 1.6
0.6 - 2.0
5 - 16
10 - 33
20 - 66
50 - 164
100 - 328
200 - 656
500 - 1640
km - mi
1 - 0.6
2 - 1.2
3.2 - 2.0
Notes
• Spacing between the gauge and the collector should be 5 m to 30 m (1)
• Spacing between the gauge and the collector can be less than 5 m if mounted on a platform in high snowfall areas (1)
• The collector should not be located on the ground level along heavily traveled city streets (12)
• Rooftop siting (2)
– Roof approximately the same height as those of surrounding buildings
– Free of dusty materials
– Buildings of 1 to 3 stories preferred
– Located near the center of the building as far as possible from exhaust or inlet vents
– Be cognizant of chimneys, exhausts, etc. on adjacent buildings

Figure 3-1. Regional and urban siting criteria for acid rain collection sites.

Reproduced from best available copy.

-- Siting Criteria for Regionally Located Wet Deposition Collection Sites (Appendix B)

-- Siting Criteria for Urban-Influenced Wet Deposition Collection Sites (Appendix C)

6. Site operators. The site operator is a key factor in the collection of quality data. Availability of site operators on a long term basis is essential for trend networks. Short term projects need to have a site operator available for the duration of the project. Sites that have well trained operators and low operator turnover are more likely to produce consistent, high quality data than sites with high operator turnover.

7. Distribution of sites. Good spacial distribution of sites across the area of interest is essential to assure meaningful trend analysis. The size of the sampling grid and the number and location of sites are dependent on the steepness of the concentration gradient and the availability of resources for site installation and operation.

3.2 Evaluation and Selection of Monitoring Sites

Once the monitoring project's siting criteria have been established (Section 3.1), the process of selecting suitable monitoring sites can be implemented. The site selection process includes:

-- Identification of candidate sites
-- Evaluation of candidate sites
-- Selection of monitoring sites

3.2.1 Identification of candidate sites. Emissions inventory, population, and land use data are used to identify regionally representative areas. This information is combined with other data to prepare a list of candidate sites. The candidate site list should include the following information about each site:

1. Site location
2. Existence of other monitoring/research activities in the area (NTN site, NDDN site, etc.)
3. Land ownership
4. Operator availability
5. Proximity to major sources of pollution (e.g., NO_x and SO_2)
6. Proximity to population centers
7. Initial contact persons
8. Land use patterns
9. Maps (USGS, others)
10. Wind rose data (where available)
11. Availability of electrical and telephone service

The above site information can be compiled from a number of sources. The Annual Directory of Governmental Air Pollution Control Agencies [Air Pollution Control Association (APCA)] is a useful reference for establishing initial contacts with state and local agencies. U.S. Geological Survey

(USGS) quadrangle maps (1:24,000 scale) provide detailed overviews of surrounding terrain, roads, towns, etc., and allow precise on-site determination of location. USGS 1:250,000 scale maps provide information on the regional terrain and location of major population centers. Land use data and ownership information can be obtained from local U.S. Soil Conservation Service (SCS) offices and county agricultural extension offices. The National Acid Precipitation Assessment Program (NAPAP) inventory provides point source information. Site documentation information for existing monitoring networks can provide useful information about point sources, terrain, etc., as well as be possible candidates for monitoring sites. Examples of this are the well documented National Trends Network (NTN) and the National Dry Deposition Network (NDDN).

Once the candidate site list has been compiled, it should be reviewed, and suitable sites identified for comprehensive on-site evaluations.

3.2.2 Evaluation of candidate sites. A comprehensive on-site evaluation is made of each candidate site to document the site's characteristics for comparison with the monitoring project's site selection criteria. A typical site evaluation would include:

1. Collection and recording of information regarding:

-- Site ownership
-- Site management
-- Site accessibility
-- Operator availability
-- Utility availability
-- Site security
-- Monitoring research activities occurring near the site
-- Local conditions (e.g., structures, trees, roads, land use, power plants, industry)
-- Regional conditions
-- Surrounding terrain and obstructions
-- Long term availability

2. Photographs of the site showing site location, identifying landmarks, and eight directional views from the site in 45° increments (north, northeast, east, etc.).

3. A detailed sketch of the site showing roads, dwellings, structures, etc., within a 250 meter radius of the site. This would include distances and azimuths to specific structures such as tree lines, power lines, roads, buildings, etc. The elevation angles, terrain, grade, and distances are determined in at least eight directions and in the directions to specific structures. A list of equipment needed to survey a site is given in Table 3-2.

EPA's National Dry Deposition Network records the site evaluation information on an NDDN Site Suitability Evaluation Form (see Appendix D).

When the candidate site evaluation is completed, all forms, data, and maps are compiled into a site information packet for review.

Table 3-2. Site Survey Equipment

Item
Rolatape Surveyor's Wheel, Model 415
Measuring tape, 100-foot (ft)
Compass, field survey grade
Clinometer or Abney level, 0 to ± 90°
Camera, 35-millimeter (mm)
Film, 24-exposure, color print
Photograph direction and documentation marker
Site Suitability Evaluation Form
Paper
Pen

3.2.3 Selection of monitoring sites. In the real world, it is rare to find a perfect site. Most sites are selected by a reviewing and evaluating process. The information collected during the comprehensive site evaluation process is reviewed. Then, the site is evaluated in terms of how well it meets the site selection criteria and how much the unmet criteria will bias the collected data. Sometimes, when site selection is driven by the need for data in a given region, site selection is determined by selection of the "best" undesirable site. It is these real world factors that make accurate documentation of site characteristics an important tool in the interpretation of dry deposition monitoring data.

3.2.4 Contractual procedures. One of the least discussed, yet potentially the single most time-consuming activity, is securing a final agreement for site use. To avert unnecessary delays in site installation, negotiation of site agreements should be initiated as soon as a site is selected. Because site agreement procedures are dependent on local city, county, and state regulations, accepted procedures are highly variable. Some of the more common forms of site use agreements include contracts, cooperative agreements, consulting agreements, leases, special-use permits, and state business licenses.

3.3 QA's Role in Site Selection

Quality assurance activities during the initial phases of the monitoring project include ensuring that:

-- Project site selection criteria are well documented and meet the needs and objectives of the project.

-- Standard operating procedures (SOP's) for site evaluation and selection are accurate and adequate for project needs.

-- SOP's for site selection are actually being followed.

-- Characteristics of selected sites are adequately documented and meet the project's siting criteria.

-- Each monitoring site has a complete site description on file.

Once the monitoring site is operational, comparison of the site description against the current site condition would be performed during routine systems audits of the site to check for changes in the site characteristics. If changes have occurred, the auditor would check to see if the changes have been documented and included in the site description along with the dates the changes occurred. Some examples of changes that could occur in regional or local surroundings are:

1. Regional changes

   -- Increases or decreases in the location and type of point sources
   -- Increases in population
   -- Construction of new industry or airports

2. Local changes

   -- Tree growth
   -- New construction in the area (buildings, roads, barns, etc.)
   -- Changes in land use
   -- Growth of underbrush, grass, etc.
   -- Deforestation (fires, etc.)

3.4 Summary

The location and characteristics of a monitoring site have a major influence on overall data quality and utility. Adherence to project-specific site selection criteria during evaluation and selection of monitoring sites will assure the site's physical location meets the needs of the monitoring project. Quality assurance's role is to ensure that:

1. Selected monitoring sites meet the site selection criteria.

2. Site descriptions are adequate, accurate, and current.

3. Changes in site characteristics are documented in the site description with the date of change.

4.0 PROCUREMENT AND TESTING OF MATERIALS AND EQUIPMENT

Timely procurement and testing of equipment and materials are essential to the success of a monitoring project. Although specific procurement, testing, and inventory control procedures vary widely from project to project, basic concepts and considerations are applicable to all monitoring projects.

4.1 Procurement of Materials and Equipment

The activities involved in the procurement of materials and equipment fall into three categories:

- -- Procurement
- -- Inspection
- -- Inventory control

4.1.1 Procurement. Procurement involves ordering and subsequent receipt of all needed materials and equipment. The mechanisms used in this procedure need to be well thought out and adequate to ensure timely implementation and continued operation of the monitoring project. It is essential that a supply of spare parts be ordered with the original equipment.

Activities associated with procurement of materials and equipment include:

- -- Developing equipment performance specifications based on project's needs
- -- Preparing purchase order
- -- Ordering equipment and materials
- -- Maintaining packing lists
- -- Maintaining equipment logs
- -- Coordinating testing of equipment
- -- Coordinating shipment of equipment to each site

Three basic steps usually followed for the procurement of equipment are:

1. Contacting various equipment manufacturers or vendors to obtain the cost of each item and its anticipated delivery date.

2. Submitting purchase requisition (PR) forms with the proper approval signatures and in accordance with company/agency policy. The PR should contain detailed specifications with respect to model number and performance parameters.

3. Contacting the vendor to place the order and arrange delivery.

4.1.2 Inspection of equipment and materials. Once the shipment of ordered equipment and materials has been received, it must be inspected to ensure that:

1. Nothing has been broken or damaged during shipment (e.g., obvious damage to shipping container, broken glassware). Any damage should be recorded in the receiving log.

2. The quantity and serial number of each item matches those listed on the packing list (any discrepancies should be recorded in the receiving log).

3. The items received are the same as those listed on the purchase order (e.g., same model number).

4. All appropriate parts have been included (e.g., power cords).

Other activities related to the inspection process include:

1. Assign and attach appropriate inventory control stickers to equipment.

2. Record equipment in the inventory log.

3. Send received items to appropriate destinations:

   a. Instrumentation should be sent to appropriate personnel for acceptance testing and calibration.

   b. Sampling media (e.g., filters) should be sent to the analytical laboratory for acceptance testing.

   c. Other equipment and material not needing additional testing should be sent to storage for shipment to the field or use in the laboratory.

4.1.3 Inventory control. Inventory control is the mechanism used to trace the movement of equipment and materials within the project. Adequate inventory control would include the following:

1. Date equipment or materials received.

2. Name, model number, serial number, and inventory control sticker number for each piece of equipment (lot number for filter material and chemicals).

3. Date equipment or material was tested for conformance to manufacturer's specifications.

4. Date equipment was calibrated.

5. Location of equipment and materials.

6. Dates and data for subsequent equipment calibrations.

4.2 Acceptance Testing and Certification of Equipment and Materials

Newly acquired equipment and materials must be tested to ensure they meet the manufacturer's specifications and the performance specifications needed for the project.

The testing procedures for materials such as the filter media used in filter packs would include:

1. Quality inspection of the filters to ensure the filters do not have weak spots, pinholes, etc.

2. Analytical analysis of a representative portion of the filters to ensure background concentrations of pollutants of interest are within acceptable ranges. These ranges must be included in the purchase requisition.

3. Recording of lot numbers and analytical results of tested material in a logbook.

Prior to field use, monitoring equipment should be subjected to extensive testing including checks to assure the equipment meets the manufacturer's specifications and any other specifications listed in the purchase requisition. At a minimum, the equipment should be tested with the procedures used for routine calibration and performance auditing of the equipment. Test procedures should include:

-- Zero drift
-- Span drift
-- Noise levels
-- Response time
-- Detection limits
-- Comparison of instrument response to known values

All testing equipment (meters, thermometers, synchronous motors, etc.) should be traceable to a primary standard and to NBS, where possible. Listed in Table 4.1 are the standard instrumentation typically used in dry deposition monitoring projects and the associated optional instrumentation used to collect wet deposition.

Table 4-1. Instrumentation Typically Used in Dry Deposition Monitoring

Standard Instrumentation

1. Ozone (O_3) analyzer
2. Wind speed sensor
3. Wind direction sensor
4. Temperature sensor
5. Delta temperature sensor
6. Solar radiation sensor
7. Rain gauge (tipping bucket)
8. Relative humidity or dew point sensor
9. Sulfur dioxide (SO_2) analyzer*
10. Nitrogen dixoide (NO_2) analyzer*
11. Integrated samplers
12. Data acquisition system (DAS)
13. Pumps and flow controllers

Optional Instrumentation (wet deposition)

1. Precipitation collector
2. Conductivity meter
3. Conductivity cell
4. pH meter
5. pH electrode
6. Rain gauge (weighing type)
7. Balance

*This equipment is not standard for all dry deposition monitoring projects.

4.3 QA's Role in Procurement and Testing of Materials and Equipment

Quality assurance activities during the initial phases of the monitoring project include ensuring that:

-- Equipment and materials being ordered will meet the project's quality objectives and needs.

-- Standard operating procedures (SOP's) for procurement and testing of equipment and materials are accurate and adequate for project needs.

-- SOP's for procurement and testing are actually being followed.

-- Documentation procedures for procurement, testing, and inventory control are adequate to meet the project's needs.

-- Adequate QC procedures are incorporated in the procurement and testing procedures to ensure the project's objectives are being met. For example, routine auditing of inventory control to ensure: (1) equipment location is correct and (2) equipment is being maintained and calibated in conformance with the SOP.

Once the monitoring project is operational, routine quality audits will be conducted on a regular schedule. A review of procedures for procurement and testing of equipment and materials is performed during the systems audit. This audit usually includes:

1. Review of current procurement and testing procedures for compliance with SOP's including observation of personnel performing acceptance tests on monitoring equipment, etc.

2. Review of equipment and instrument test results for compliance with acceptance criteria listed in the purchase requisition and the SOP.

3. Review of routine QC activities for conformance to the SOP. Any problems or exceedances will be checked to ensure corrective action was taken and the results were documented (e.g., inventory control QC check revealed an ozone monitor was not at indicated location. Check to see that the proper procedures were followed to locate instrument and correct the inventory list.)

4. Review of logbooks, inventory lists, etc., for accuracy, adequacy, and compliance with the SOP.

5. Inspection of the equipment testing area for:

-- Adequate space
-- Cleanliness
-- Adherence to SOP for calibration frequency, traceability, etc., of test equipment
-- Adherence of personnel to test procedures in the SOP's
-- Documentation of all test results, calibration dates, etc.
-- Performance and documentation of QC checks in conformance with the SOP

6. Review of procurement procedures to ensure that equipment and materials are being ordered, received, and tested in a timely manner consistent with the project's needs.

4.4 Summary

Timely procurement and testing of equipment and materials is essential to the implementation and smooth operation of a monitoring project. Accurate inventory records provide a history of how each instrument is functioning and an indication of instrument data quality.

5.0 SITE INSTALLATION

Site installation can be a very simple process or a very complex one depending on the number of sites to be installed, the type of measurements being taken, the complexity of the siting criteria, and the geographic factors of the site location (e.g., mountain, jungle, desert, forest). When monitoring projects involve more than one site, consistent procedures for site installation and initiation are needed to assure the quality and comparability of data between sites.

5.1 Scheduling Site Installation

Scheduling is an important aspect of site installation, especially in multi-site networks. The site installation schedule should strive to minimize travel and shipment of equipment and maximize the efficiency of the site installation team. One way to achieve this is to schedule site installations in geographic clusters (e.g., 2 sites in North Carolina and 1 site in Virginia or for regional intensive networks, schedule installations at three locations within a state). Another way to minimize travel time and shipping costs is to arrange with manufacturers to drop-ship field equipment such as shelters, towers, rain gauges, and wet-dry collectors at or near each site. This would not include equipment requiring acceptance testing and calibration (ozone monitors, data acquisition systems, meteorological sensors, etc.).

Time delays of 4 to 5 weeks between the shelter, service pole, and box installation and the provision of electrical power are common occurrences. Because installation of the shelter and tower does not require on site power, site installation can be divided into two phases: site installation and site initiation. This division proves to be very helpful to large networks that are trying to schedule installation of numerous sites at scattered locations. It allows them to have one team install sites and another initiate site operation.

5.2 Site Installation

Site installation involves the delivery and installation of the shelter, towers, and monitoring equipment. It usually requires several days to prepare the site and install the equipment. Table 5-1 lists the support equipment required to install the NDDN monitoring sites.

Table 5-1. Support Equipment Required for Site Installation

Item
Power auger, 5-horsepower (hp)
Gasoline can, 5-gallon (gal)
Auger bits, 16-inch, 10-inch, and 6-inch by 3 ft
Theodolite and tripod
Compass, field-survey-grade
Ratcheting jack, 5-ton
Post-hole digger
Post-hole alignment jig
Shovels (2)
Electric chain saw
Gasoline chain saw
Miscellaneous tools
Electric drill and bits
Miscellaneous wiring, connectors, tubing (1 station-equivalent)
Gasoline-powered generator, 110 VAC, 4 kilowatts (kW)
Water cooler
Extension ladder, 20-ft
Tarpaulin
Safety equipment (hard hat, safety belt, etc.)

Source: ESE, 1987

Specific procedures for site installation are variable depending on the pollutant parameters being measured and the equipment being installed. EPA's NDDN uses measurement equipment typical of most dry deposition monitoring projects. Tables 5-2 and 5-3 list the equipment installed at NDDN sites.

Table 5-2. NDDN Monitoring Equipment Inside the Shelter

Item	Manufacturer	Model No.	Quantity
Ozone analyzer with in-line filter	Thermo Electron	49-103	1
DAS	Odessa	DSM-3260	1
Electronically erasable programmable read-only memory (EEPROM) (64K)	Odessa	CSM-2864-8I	2
Personal computer (PC) for DAS	Computer Library	Turbo XT	1
American filter pack*	Savillex	--	As scheduled
Printer	Star	SD-10	1
Pump	Thomas	107-CA11	1
Flow controller	Teledyne Hastings	CST-10K	1
Flow controller power supply	Teledyne Hastings	CPR-1	1
Modem	Packard-Bell	IS/EM-1200	1
Tubing, wiring	Various	--	As needed
Meteorological translator board assembly	Climatronics	F460	1
Multiplex recorder	Climatronics	F460	1
Solenoid valve	Skinner	V53DA2VAC2	2

*Shipped from ESE laboratory

Source: ESE, 1987

Table 5-3. NDDN Meteorological Monitoring Equipment Outside the Shelter

Item	Manufacturer	Model No.	Quantity
Tilt-down tower	Aluma Tower	AT-044	1
Meteorological tower	Climatronics	C-33	1
Wind direction sensor	Climatronics	F-460 system	1
Wind vane	Climatronics	F-460 system	1
Wind speed sensor	Climatronics	F-460 system	1
Anemometer cups	Climatronics	F-460 system	1
Wind speed/wind direction heater assembly	Climatronics	F-460 system	1
Heater power cord	Climatronics	F-460 system	1
Sensor crossbar	Climatronics	F-460 system	1
Solar radiation sensor	Climatronics	F-460 system	1
Mast adapter	Climatronics	F-460 system	1
Aspirated temperature sensor	Climatronics	F-460 system	1
Aspirated temperature and relative humidity sensors	Climatronics	F-460 system	1
U-bolts for temperature sensors	Climatronics	F-460 system	4
Tipping bucket assembly	Climatronics	F-460 system	1
Signal cable harness	Climatronics	F-460 system	1
Rain gauge/solar radiation post	ESE	--	1
Grounding kit	Climatronics	--	1
Optional			
Wet/dry collector	Aerochem Metrics	301	1
Rain gauge	Belfort	5915R-12	1

Source: ESE, 1987

General activities included in site installation are:

1. Site preparation. This involves the removal of trees, low-lying vegetation and overgrowth to allow shelter and tower installation and meet siting criteria. The trees, vegetation, and overgrowth that need to be removed should have been specified during the site selection process.

2. Shelter support installation. Shelter support selection is dependent on existing site conditions and local building codes. Commonly used supports are:

-- Pressure-treated marine timbers which are easy to cut and are guaranteed free from rot and decay for 35 years

-- Concrete pylons

-- Concrete slab

3. Shelter installation. Placement of the shelter on and attachment to the shelter support.

4. Tower support installation. Two common methods used to support (mount) towers are:

-- Sub-surface mount: A 3-foot base section of the tower is cast in the concrete foundation.

-- Flush mount: Threaded studs (used to connect the tower to the tower support) are cast in a 3-foot-deep concrete foundation.

It should be noted that the tower support concrete base should be deeper than the frost line. Depending on site location, the tower support could extend much deeper than 3 feet.

5. Tower installation. Includes the following activities:

-- Attach tower to tower support
-- Guy the tower
-- Install lightning rod and attach ground cable to a grounding spike

6. Installation of monitoring equipment. Activities associated with the arrangement and installation of shelter-contained (internal) equipment are:

a. Unpack equipment from shipping containers.

b. Place equipment in approximate positions they will occupy during normal operations.

c. Verify that all equipment needed for site operation is in place and contains appropriate inventory stickers.

d. Install equipment in accordance with manufacturer's guidelines and project SOP's. This includes attachment of power cords, assembling zero air system and connection to appropriate instrumentation; connection of instruments to the data acquisition system (DAS); attachment of external sample lines to monitors, etc.

Activities associated with the installation of external monitoring equipment include:

a. Attachment of meteorological sensors and sensor housings to the meteorological tower at designated heights.

b. Installation of power and signal cables between sensors and equipment shelter.

c. Proper alignment of the wind vane and sensor in relation to true north.

d. Installation of filter pack sampling head.

e. Installation of all external sampling lines (e.g., filter pack, ozone, etc.).

f. Installation of tipping rain gauge.

g. Installation of solar radiation system.

h. Installation of wet deposition sampling equipment (if it is being used at site).

   -- Rain gauge
   -- Wet/dry sampler

i. Vertical alignment of the towers.

Other activities associated with site installation would include:

a. Set up site record-keeping systems including:

   -- Site description/document records
   -- Parts inventory record
   -- Site logbook - site logbook should contain entries of activities performed during the site installation

b. Assure site contains necessary site documents and manuals.

   -- Site operator manual containing current SOP's
   -- Instrument manuals

c. Assure that all supplies needed for site operation are available and easily accessible.

-- Disks for PC
-- Tools needed for maintenance of equipment
-- Expendable supplies needed for site operation (e.g., filters for instrument inlets, site report forms, mailing labels, printer ribbons)

Once the monitoring equipment has been installed and connected to the appropriate sample lines, input ports on the DAS, etc., the whole system should be inspected to assure the site has been set up in accordance with the SOP's and manufacturer guidelines. If electrical utilities are already available, all systems should be turned on and given a preliminary operation's check (e.g., do lights work; are the meteorological sensors giving a reasonable response; do the pumps work).

If power and telephone service have not been installed, site installation personnel should confirm that installation or connection is arranged and will be accomplished on schedule.

5.3 Site Initiation

Site initiation is the last phase before a monitoring site begins to collect data on a routine basis. It involves the final installation, inspection, and calibration of all the monitoring and data acquisition equipment. It is essential that the site operator actively participate in this phase. This participation provides the operator with a good review of site operations and the opportunity to ask questions and receive clarification on any site procedures. (See Section 7.0 for information on site operator training.)

General activities included in site initiation are:

1. Instrument calibration. Each instrument is calibrated in accordance with the project's SOP. The calibration equipment and transfer standards should be traceable to a primary standard and NBS (whenever possible). Table 5-4 lists the equipment that is calibrated during the site initiation phase of an NDDN monitoring site.

Table 5-4. Monitoring Equipment to be Calibrated Upon Installation

Thermo Electron Model 49-103 Ozone Monitor
Solar pyranometer
Tipping bucket rain gauge
Wind direction sensor
Wind speed sensor
Temperature and delta temperature sensors
Mass flow controller
Relative humidity sensor
Data acquisition system

Source: ESE, 1987

Table 5-5 lists the calibration and testing equipment used during the site initiation phase of an NDDN monitoring site.

Table 5-5. Calibration and Testing Equipment

Thermo Electron 49 PS ozone transfer standard
Synchronous motors (600 and 1800 rpm) for wind speed
Field-grade compass for wind direction
Theodolite
NBS-traceable digital voltmeter
NBS-traceable mercury in glass thermometer
NBS-traceable aspirated psychrometer
Slack tube manometer
NBS-traceable solar pyranometer
NBS-traceable mass flow meter

Note: NBS - National Bureau of Standards

Source: ESE, 1987

2. Data acquisition system (DAS) check. The DAS will be checked thoroughly for proper installation and connection to all instrumentation. Instrument calibration data will be entered into the DAS and proper functioning of all operations will be verified.

3. Siting criteria check. Site installation will be re-checked for compliance with the project's siting criteria.

4. Documentation of site initiation. All activities performed during site initiation will be documented in the site operator's logbook. (Included in this should be the date and time the site begins routine operation.) Copies of all instrument calibration forms will be left at the site and maintained as part of the site's calibration record.

5. In-depth site review. All activities performed during the site installation phase will be reviewed to ensure the site is ready to begin routine operation. This review can be facilitated by use of a site acceptance checklist. This checklist outlines each item to be inspected and provides a place to check off as it is inspected and approved. An example of NDDN's site acceptance checklist is shown in Appendix E. A copy of this site acceptance checklist should be kept at the site.

5.4 Follow-up Review

Upon completion of the initiation phase, the monitoring site is ready to begin routine operation. A follow-up review of site operation should be scheduled within the first few months of operation. The purpose of this review is to ensure the site is being operated in a manner consistent with the site's operating procedures. This review should be conducted by personnel experienced enough in the site operation procedures to detect any deviations from the standard operating procedures and assure that the site operation is comparable to other sites in the project.

5.5 QA's Role in Site Installation

QA's role in site installation is to ensure that the installed site meets the project's:

-- Siting criteria
-- Data quality objectives
-- Needs

QA activities during the project planning phase include ensuring that:

1. Standard operating procedures (SOP's) for site installation are accurate and adequate for project needs. This would include detailed procedures for:

-- Installation and calibration of site monitoring equipment

-- Installation of physical structures (e.g., towers, shelter)

-- In-depth site acceptance review for installed sites using on-site acceptance checklist

2. The project's schedule for procurement, installation, and initiation of monitoring sites is timely and meets the project's needs.

Depending on the number of sites, location, budgets, etc., QA activities during site installation can range from minimal to intense. At a minimum, one of the sites needs to be audited in-depth during installation for conformance to the site installation criteria.

Once the site has been installed and is operating in a routine manner, a quality audit of the site needs to be scheduled (usually within the first month of operation). This quality audit, including both systems and performance audits, will be the first of many routine audits to document the site's conformance to siting criteria, sampling SOP's, data quality requirements, calibration frequency, etc. This first audit should be in-depth and very detailed. Emphasis should be on documentation as well as performance. It is essential for the site operator to:

-- Record all activity in the site logbook

-- Keep records of site operations in a systematic, comprehensive manner

-- Consistently follow SOP's

-- Complete site operation report sheets in an accurate, comprehensive manner

-- Ship all samples, records, forms to the central laboratory in a timely manner

-- Be observant and document and report any change in instrument performance or site conditions to appropriate personnel

-- Be knowledgeable about all aspects of site operation

-- Be knowledgeable about and know location of site operations manual, instrument manuals, DAS manuals, etc.

Deviations from standard site operation procedures need to be identified and corrected during the early stages of routine site operation. Delayed auditing of sites can lead to non-standard site operation that may affect data quality.

5.6 Summary

Timely installation of monitoring sites is essential to the implementation and operation of a monitoring project. Consistent procedures for site installation and initiation are needed to assure the quality and comparability of collected data. Documentation of a site's ability to collect data of known and acceptable quality begins during site installation. Accurate documentation of the site's installation procedures, equipment calibrations, and acceptance review lay the foundation upon which the site's performance record is built.

6.0 SITE OPERATIONS

As the source of all collected data, the monitoring site is the driving force for most project activities and is the single most important factor affecting data quality. No other project operation can compensate or make-up for poor site operation. Other areas can enhance data quality or detract from it, but only the monitoring site can determine the basic level of data quality. Therefore, it is critical that the precision and accuracy requirements established for each measured pollutant meet the project's data quality requirements and needs. Data quality requirements are project specific and are usually based on a compromise between what the researchers would like to have and what they absolutely have to have. The determining factors most often are budgets and the accuracy and precision limitations of available equipment. Table 6-1 lists the precision and accuracy objectives for monitoring sites in EPA's National Dry Deposition Network.

Once a project has established the precision and accuracy requirements for the field measurements, it must develop procedures to ensure the site is operating within these acceptable limits. This is generally accomplished through:

-- Calibration of monitoring equipment on a regular schedule (e.g., NDDN calibrates quarterly).

-- Inclusion of quality control checks in routine site operations (e.g., periodic zero, span, and precision checks of ozone instruments).

-- Quality auditing of monitoring sites on a regular schedule (e.g., semiannual).

As an example, a table outlining measurement parameters, measurement devices, calibration frequency, and audit frequency for the NDDN is given in Appendix F.

6.1 Routine Site Operation

Site operation procedures are project specific. They can be relatively simple as in projects collecting filter pack, ozone, and meteorological data or more complicated as in projects collecting meteorological, ozone, annular denuder, wet deposition, and particle sizing data. Each monitoring project must develop comprehensive, written SOP's (see Section 8.5.2) for site operation. This would include SOP's for:

Table 6-1. Precision and Accuracy Objectives of Field Measurements (*in situ*)

Measurement parameter	Method*	Acceptance criteria+	
		Precision	Accuracy
Wind speed	Anemometer	± 0.5 m/s	± 0.2 m/s
Wind direction	Wind vane	± 5°	± 2°
Relative humidity	Humidity sensor	± 10% (of full scale)	± 10%
Solar radiation	Pyranometer	± 10% (of full scale)	± 10%
Precipitation	Rain gauge	± 10% (of reading)	± 0.01 inch**
Ambient temperature	Thermistor	± 0.5°C	± 0.25°C
Delta temperature	Thermistor	± 0.2°C	± 0.1°C
Ozone (O_3)	O_3 analyzer	± 10% (of reading)	± 10%
Filter pack flow	Mass flow meter	± 0.15 Lpm	± 10%

Note: Lpm = liters per minute
m/s = meters per second

*Refer to the NDDN Field Operations Manual.

+Field precision criteria apply to collocated instruments, and accuracy criteria apply to calibration of instruments (refer to Section 8.0).

**For target value of 0.10 inch.

Source: ESE, 1987

-- Routine site operation
-- Operation and maintenance of equipment
-- Record-keeping
-- Information transfer (data, checksheets, etc.)
-- Sample collection and shipment

6.1.1 Site operator activities. Site operators are responsible for routine operation and maintenance of the monitoring site. The monitoring site is visited on a regular schedule. These visits are dependent on the project's sampling schedule and visits vary from daily to weekly. During each visit, the operator performs a series of procedures and checks to collect data and ensure the site is operating properly. A checksheet should be used by the operator during routine site visits. These checksheets (similar to the ones used by the NDDN shown in Figure 6-1 and the wet deposition checksheet shown in Figure 6-2) are used to:

-- Provide documentation of the site's operating status, and
-- Ensure the operator is performing all required tests and checks.

Activities typically performed by an operator during a site visit would include:

1. Sign-in by site operator in the site logbook.

2. A general inspection of site and shelter conditions. These activities include:

   -- Inspection of shelter and grounds for unauthorized entry or vandalism.

   -- Inspection of utilities, air conditioning/heating system, and shelter minimum/maximum thermometer for proper operation. Findings are recorded in the site logbook.

   -- Recording local site conditions in the site logbook (snow, dew, frost, foliage, etc.)

3. Sample change-out (integrated sampler, wet-dry collector).

4. Collection of data/samples for shipment to the central laboratory. This includes:

   -- Integrated samples
   -- Wet deposition samples (if collected)
   -- Continuous monitoring data (ozone, SO_2, etc.)
   -- Meteorological data
   -- Checksheets, data forms, charts, etc.
   -- Data from the DAS

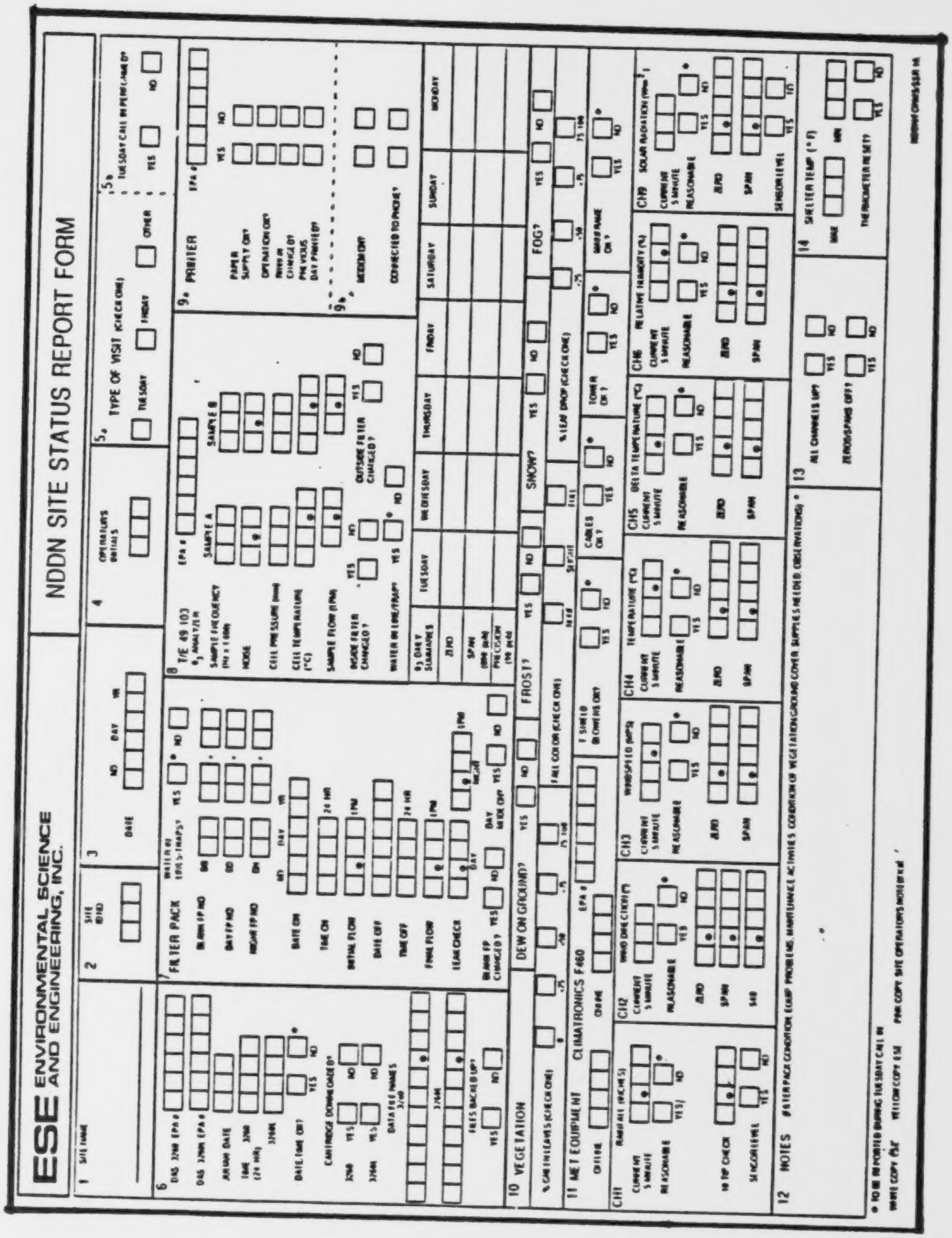
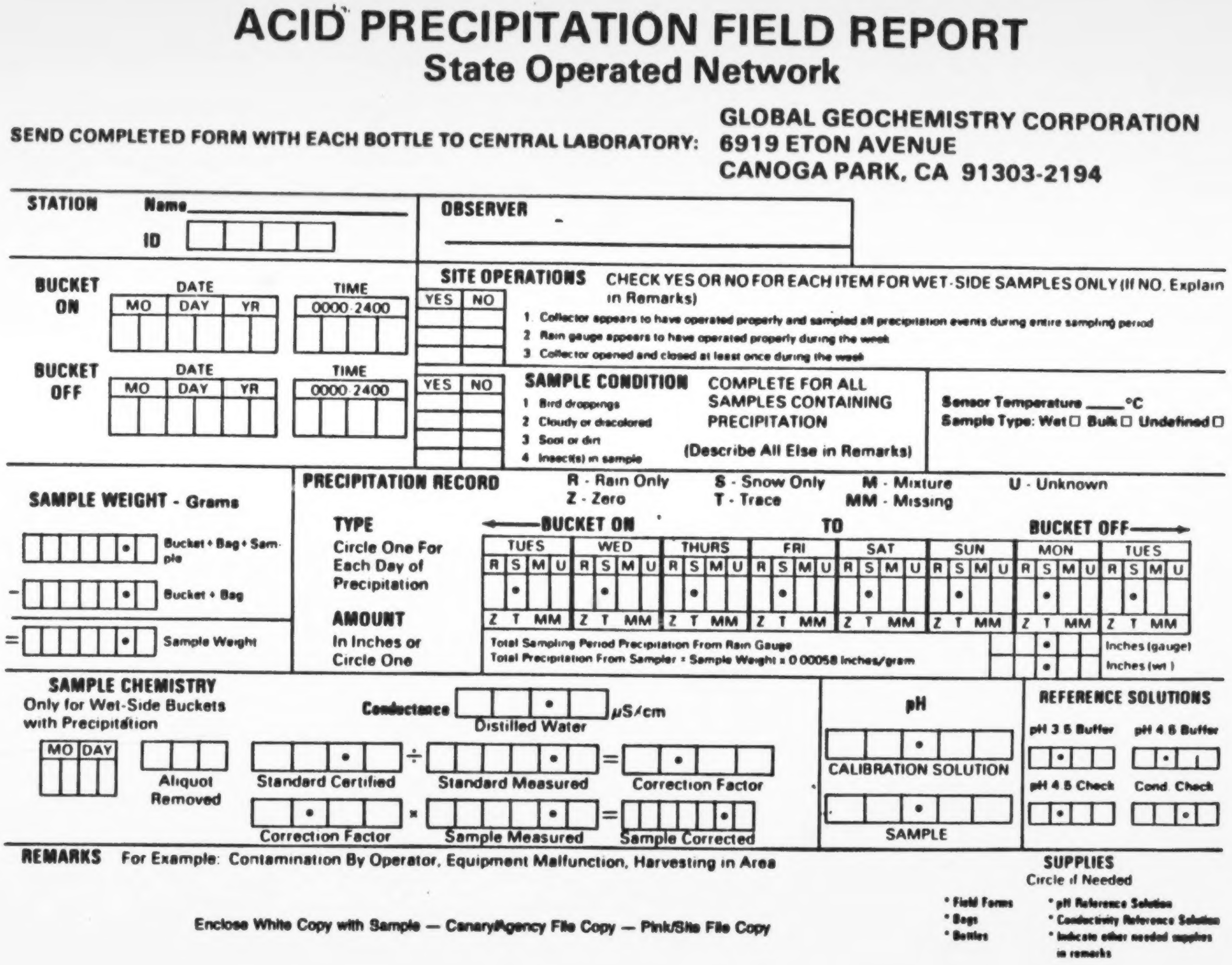


Figure 6-1. NDDN site status report form.

Reproduced from best available copy.



ACID PRECIPITATION FIELD REPORT

State Operated Network

SEND COMPLETED FORM WITH EACH BOTTLE TO CENTRAL LABORATORY:

GLOBAL GEOCHEMISTRY CORPORATION
6919 ETON AVENUE
CANOGA PARK, CA 91303-2194

STATION Name ____________ ID ☐☐☐☐☐

OBSERVER ____________

	DATE			TIME
	MO	DAY	YR	0000-2400
BUCKET ON				
BUCKET OFF				

SITE OPERATIONS CHECK YES OR NO FOR EACH ITEM FOR WET-SIDE SAMPLES ONLY (If NO, Explain in Remarks)

YES	NO	
		1. Collector appears to have operated properly and sampled all precipitation events during entire sampling period
		2. Rain gauge appears to have operated properly during the week
		3. Collector opened and closed at least once during the week

SAMPLE CONDITION COMPLETE FOR ALL SAMPLES CONTAINING PRECIPITATION (Describe All Else in Remarks)

YES	NO	
		1. Bird droppings
		2. Cloudy or discolored
		3. Soot or dirt
		4. Insect(s) in sample

Sensor Temperature _____°C
Sample Type: Wet ☐ Bulk ☐ Undefined ☐

SAMPLE WEIGHT - Grams

☐☐☐☐☐.☐ Bucket + Bag + Sample
− ☐☐☐☐☐.☐ Bucket + Bag
= ☐☐☐☐☐.☐ Sample Weight

PRECIPITATION RECORD

R - Rain Only
Z - Zero
S - Snow Only
T - Trace
M - Mixture
MM - Missing
U - Unknown

←BUCKET ON TO BUCKET OFF→

	TUES	WED	THURS	FRI	SAT	SUN	MON	TUES
TYPE Circle One For Each Day of Precipitation	R S M U	R S M U	R S M U	R S M U	R S M U	R S M U	R S M U	R S M U
AMOUNT In Inches or Circle One	☐.☐☐	☐.☐☐	☐.☐☐	☐.☐☐	☐.☐☐	☐.☐☐	☐.☐☐	☐.☐☐
	Z T MM	Z T MM	Z T MM	Z T MM	Z T MM	Z T MM	Z T MM	Z T MM

Total Sampling Period Precipitation From Rain Gauge ☐☐.☐☐ Inches (gauge)
Total Precipitation From Sampler = Sample Weight x 0.00058 Inches/gram ☐☐.☐☐ Inches (wt.)

SAMPLE CHEMISTRY
Only for Wet-Side Buckets with Precipitation

MO DAY ☐☐☐☐

☐☐☐ Aliquot Removed

Conductance ☐☐.☐ μS/cm Distilled Water

☐☐.☐☐ Standard Certified ÷ ☐☐☐☐.☐ Standard Measured = ☐.☐☐☐ Correction Factor

☐.☐☐☐ Correction Factor × ☐☐☐☐.☐ Sample Measured = ☐☐☐☐☐.☐ Sample Corrected

pH

☐☐.☐☐☐ CALIBRATION SOLUTION

☐☐.☐☐☐ SAMPLE

REFERENCE SOLUTIONS

pH 3.5 Buffer ☐.☐☐
pH 4.5 Buffer ☐.☐☐
pH 4.5 Check ☐.☐☐
Cond. Check ☐☐.☐

REMARKS For Example: Contamination By Operator, Equipment Malfunction, Harvesting in Area

SUPPLIES
Circle if Needed

- Field Forms
- Bags
- Bottles
- pH Reference Solution
- Conductivity Reference Solution
- Indicate other needed supplies in remarks

Enclose White Copy with Sample — Canary/Agency File Copy — Pink/Site File Copy

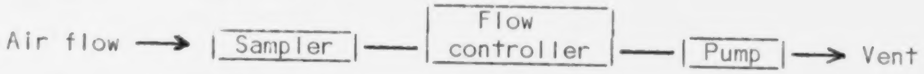
Figure 6-2. Acid precipitation field report form.

5. Equipment checks. Examples of these are:
   - Zero and span checks of instruments (meteorological systems, ozone, etc.).
   - Leak checking the integrated sampler flow system.
   - Checking the solar radiation detector for foreign matter (clean if necessary).
   - Checking the outputs from the meteorological systems for reasonableness.
6. Performing required maintenance (e.g., change instrument filters)
7. Documenting all site activities in appropriate logbooks and on project status report sheets.
8. Reporting site status and any problems to the central laboratory. (Some projects require verbal communication between site operator and the laboratory after each sample change-out.)
9. Sign-out by operator in site logbook.
10. Securing the site (turn out lights, lock door, etc.)
11. Shipment of samples, data forms, collected data, etc., to central laboratory.

A flow diagram for site operator activities in the NDDN is shown in Figure 6-3.

6.2 Integrated Samplers

One of the most common methods employed in the collection of dry deposition samples is the integrated sampler. These samplers quantitatively collect particle and gaseous pollutants by pulling a known volume of air through a series of filters, treated filters, liners, or coated denuder tubes. Integrated sampler systems usually consist of the integrated sampler, a flow controller, and pump. See diagram below.



Sampling times vary from a few hours to 7 days with flow rates ranging from 1 to 20 L/min. (e.g., a sampler might run for 24 hours at 20 L/min. or 7 days at 1.5 L/min.). Table 6-2 lists some of the sampling media used in, and the pollutant species collected by, integrated samplers.

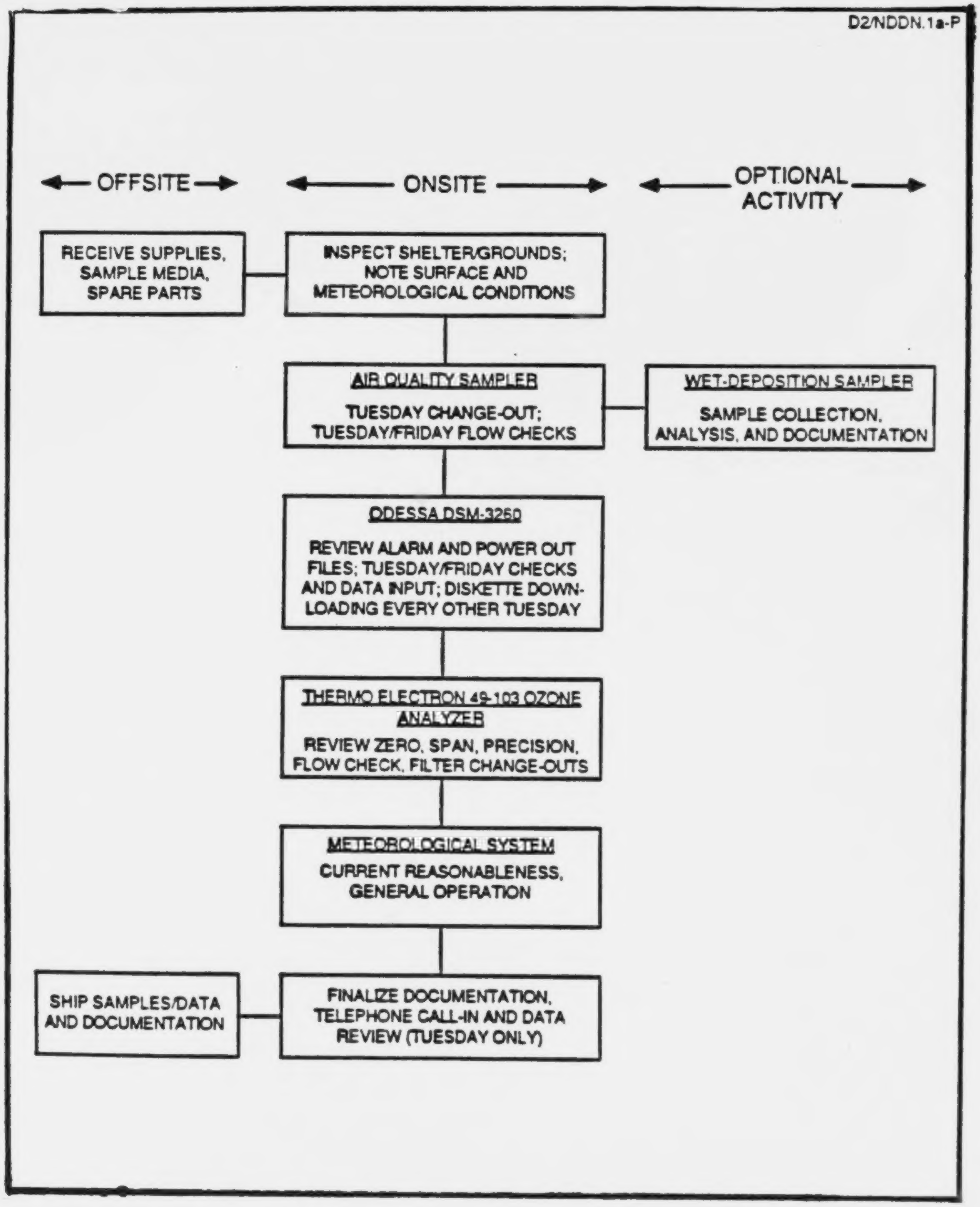

D2/NDDN.1a-P
OFFSITE
ONSITE
OPTIONAL ACTIVITY
RECEIVE SUPPLIES, SAMPLE MEDIA, SPARE PARTS
INSPECT SHELTER/GROUNDS; NOTE SURFACE AND METEOROLOGICAL CONDITIONS
AIR QUALITY SAMPLER
TUESDAY CHANGE-OUT; TUESDAY/FRIDAY FLOW CHECKS
WET-DEPOSITION SAMPLER
SAMPLE COLLECTION, ANALYSIS, AND DOCUMENTATION
ODESSA DSM-3260
REVIEW ALARM AND POWER OUT FILES; TUESDAY/FRIDAY CHECKS AND DATA INPUT; DISKETTE DOWNLOADING EVERY OTHER TUESDAY
THERMO ELECTRON 49-103 OZONE ANALYZER
REVIEW ZERO, SPAN, PRECISION, FLOW CHECK, FILTER CHANGE-OUTS
METEOROLOGICAL SYSTEM
CURRENT REASONABLENESS, GENERAL OPERATION
SHIP SAMPLES/DATA AND DOCUMENTATION
FINALIZE DOCUMENTATION, TELEPHONE CALL-IN AND DATA REVIEW (TUESDAY ONLY)

Figure 6-3. Flow diagram for site operator activities.

Table 6-2. Integrated Samplers: Sampling Media and Collected Species

Sampling material	Type	Pollutant species collected
Teflon	Filter	Particulates (SO_4^{-2}, NO_3^-)
Nylon	Filter, liner	HNO_3
Carbonate/glycerin	Treated filter, coated denuder	SO_2 SO_2, HNO_3
Triethanolamine (TEA)	Treated filter	NO_2
Citric acid	Treated filter, coated denuder	NH_3 NH_3
Oxalic acid	Treated filter	NH_3
Nafion	Liner	NH_3

The type of integrated sampler most suited for use in a monitoring project is dependent on the project's objectives. A visibility monitoring project would use the integrated sampler method giving the most reliable particulate data, whereas a forest response project might utilize a sampler that gives more reliable nitric acid (HNO_3) data. Some projects use a combination of integrated samplers. For example, EPA's ACID MODES project is using the filter pack and a modified Transition Flow Reactor (TFR). The modified TFR consists of a tube operated in transition flow with nylon and nafion liners to collect HNO_3 and NH_3. This will allow the project to collect accurate data for HNO_3 and NH_3. The filter pack, operated separately from the TFR, will provide comparability of data with other projects such as NDDN.

6.2.1 Filter pack. One of the most commonly used integrated samplers is the filter pack. Examples of commonly used filter packs are the Canadian filter pack shown in Figure 6-4 and the American filter pack (used in EPA's NDDN) shown in Figure 6-5. Filter packs are generally used to collect particles, HNO_3, and SO_2, respectively. Some filter packs also include a citric acid treated filter to collect NH_3.

1. Advantages:

   -- Simple to use
   -- Inexpensive
   -- Analysis by routine methods
   -- Comparability with other networks (e.g., Canadian, NDDN, etc.)
   -- Long history of application
   -- Quantitative for non-volatile species

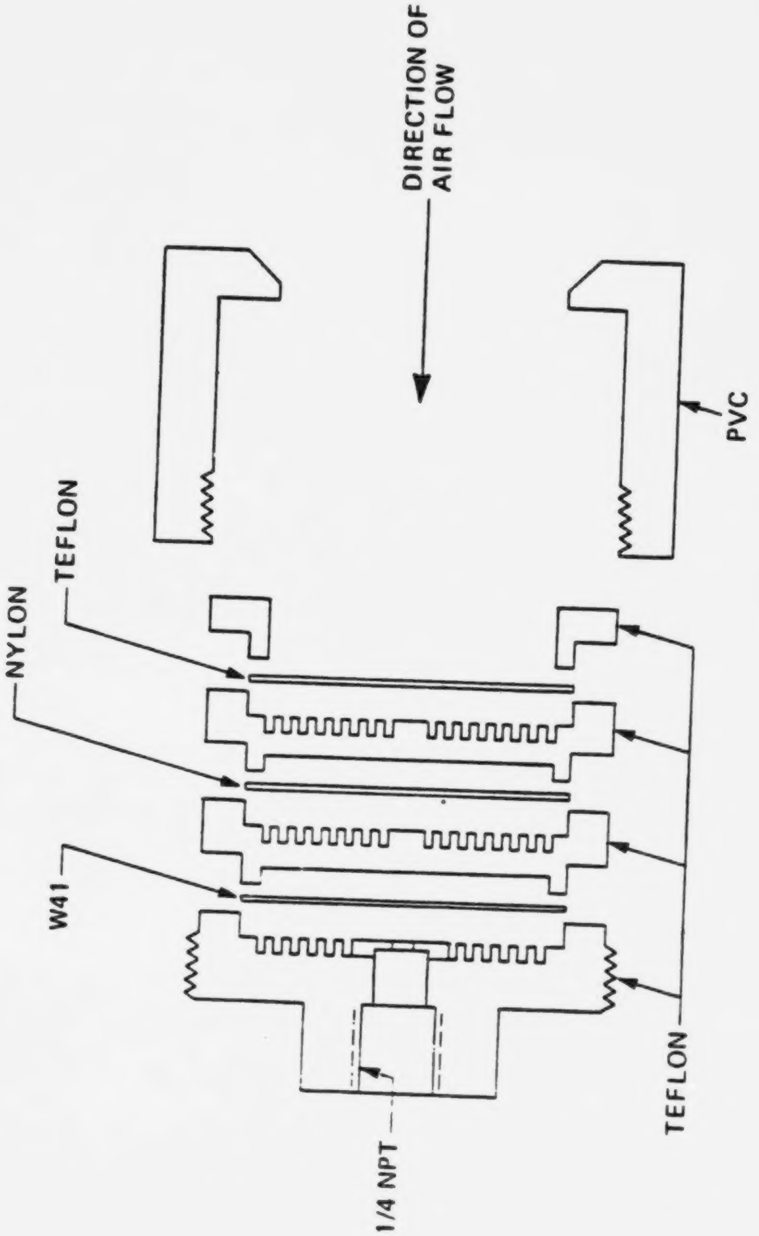

DIRECTION OF AIR FLOW
PVC
TEFLON
NYLON
W41
TEFLON
1/4 NPT

Figure 6-4. Canadian filter pack assembly.

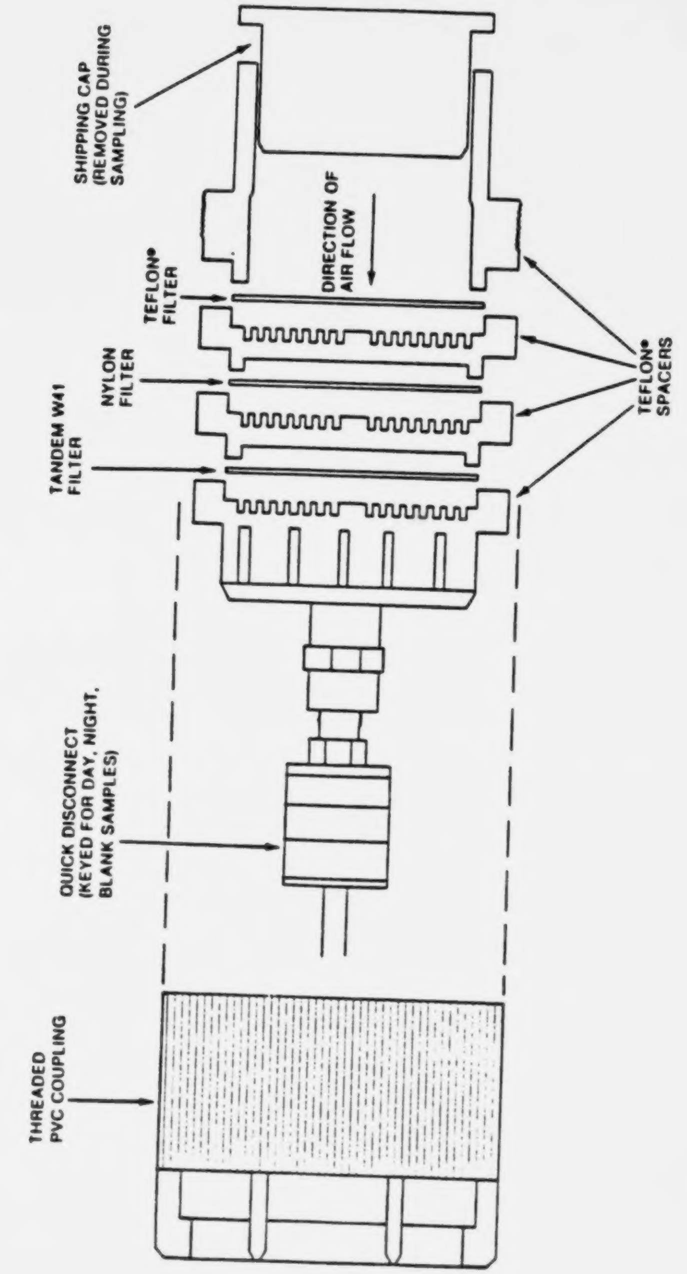

SHIPPING CAP (REMOVED DURING SAMPLING)
DIRECTION OF AIR FLOW
TEFLON® FILTER
NYLON FILTER
TANDEM W41 FILTER
TEFLON® SPACERS
QUICK DISCONNECT (KEYED FOR DAY, NIGHT, BLANK SAMPLES)
THREADED PVC COUPLING

Figure 6-5. American filter pack assembly.

2. Disadvantages:

-- Problem with underestimating particulate NO_3 and overestimating HNO_3 in areas containing large amounts of particulate NH_4NO_3. This is caused by NH_4NO_3 volatilizing from the particulate filter and being absorbed on the nylon filter, where the nitrate is then erroneously reported as HNO_3.

-- SO_2 is absorbed on the nylon filter. To avoid underestimating ambient SO_2 concentrations, the SO_2 collected on the nylon filter is added to the SO_2 collected on the treated Whatman filter.

6.2.2 Transition flow reactor (TFR). The TFR is an integrated sampler consisting of a tube operated in transition flow having a short section lined with filters to collect gaseous species of interest. Following the tube is a filter pack containing filters to remove particles, remaining HNO_3, NH_3, etc. The tube liners for HNO_3 and NH_3 are nylon and nafion, respectively. These liners remove a constant percentage of the species of interest (e.g., one TFR design removes 9% HNO_3 and 17% NH_3). This constant is dependent on the geometry of the sampler, size of the sampler, and the flow rate. The cyclone inlet dual TFR system shown in Figure 6-6 and the funnel inlet TFR system shown in Figure 6-7 were used in the Carbon Species Methods Comparison Study (CSMCS) in 1986.

1. Advantages:

-- Avoids problem with gas and particulate phase NO_3
-- Relatively simple to use

2. Disadvantages:

-- Higher detection limits for HNO_3. Because the TFR collects only 9% of the available HNO_3, its detection limit is approximately 10 times higher than that for the filter pack.

-- Does not do a good job on particulate nitrate if the gas to particle phase ratio is larger than a factor of 2 or 3 (e.g., the gas/particle ratio at Penn State is 4:1, a factor of 4). The TFR might not be a good method for visibility projects.

6.2.3 Annular denuder. The annular denuder is an integrated sampler consisting of a series of coated denuders to collect the gaseous species of interest followed by a filter pack to collect particulates and volitalized compounds. It is generally used with a teflon cyclone or impactor inlet to remove large particles. Figure 6-8 shows the U.S.-Italy annular denuder acid deposition sampling system.

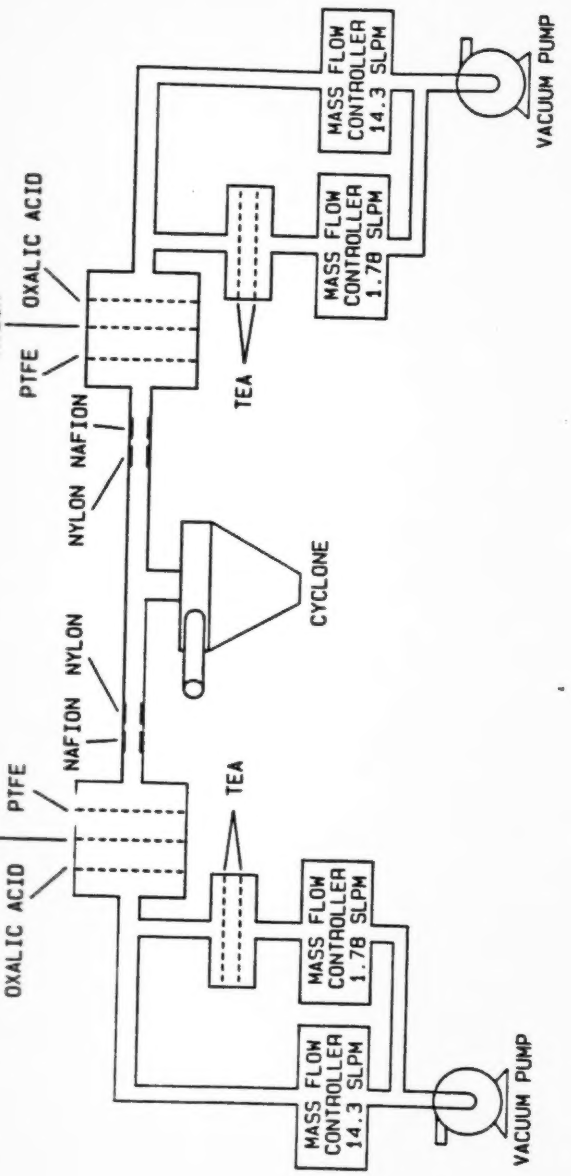

MASS FLOW CONTROLLER 14.3 SLPM
VACUUM PUMP
MASS FLOW CONTROLLER 1.78 SLPM
OXALIC ACID
NYLON
PTFE
TEA
NAFION
NYLON
CYCLONE
NYLON
NAFION
PTFE
NYLON
OXALIC ACID
TEA
MASS FLOW CONTROLLER 1.78 SLPM
MASS FLOW CONTROLLER 14.3 SLPM
VACUUM PUMP

Figure 6-6. Cyclone inlet dual TFR system.

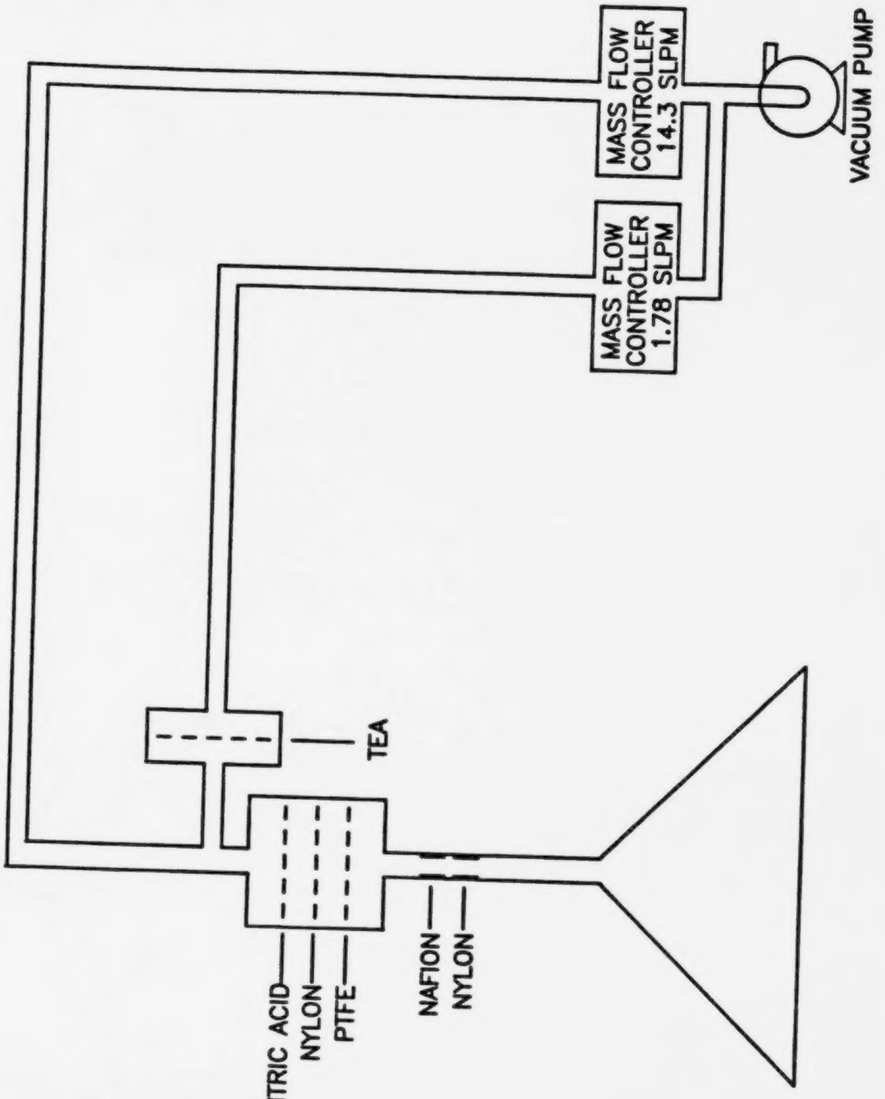

MASS FLOW CONTROLLER 14.3 SLPM
VACUUM PUMP
MASS FLOW CONTROLLER 1.78 SLPM
TEA
CITRIC ACID
NYLON
PTFE
NAFION
NYLON

Figure 6-7. Funnel inlet TFR system.

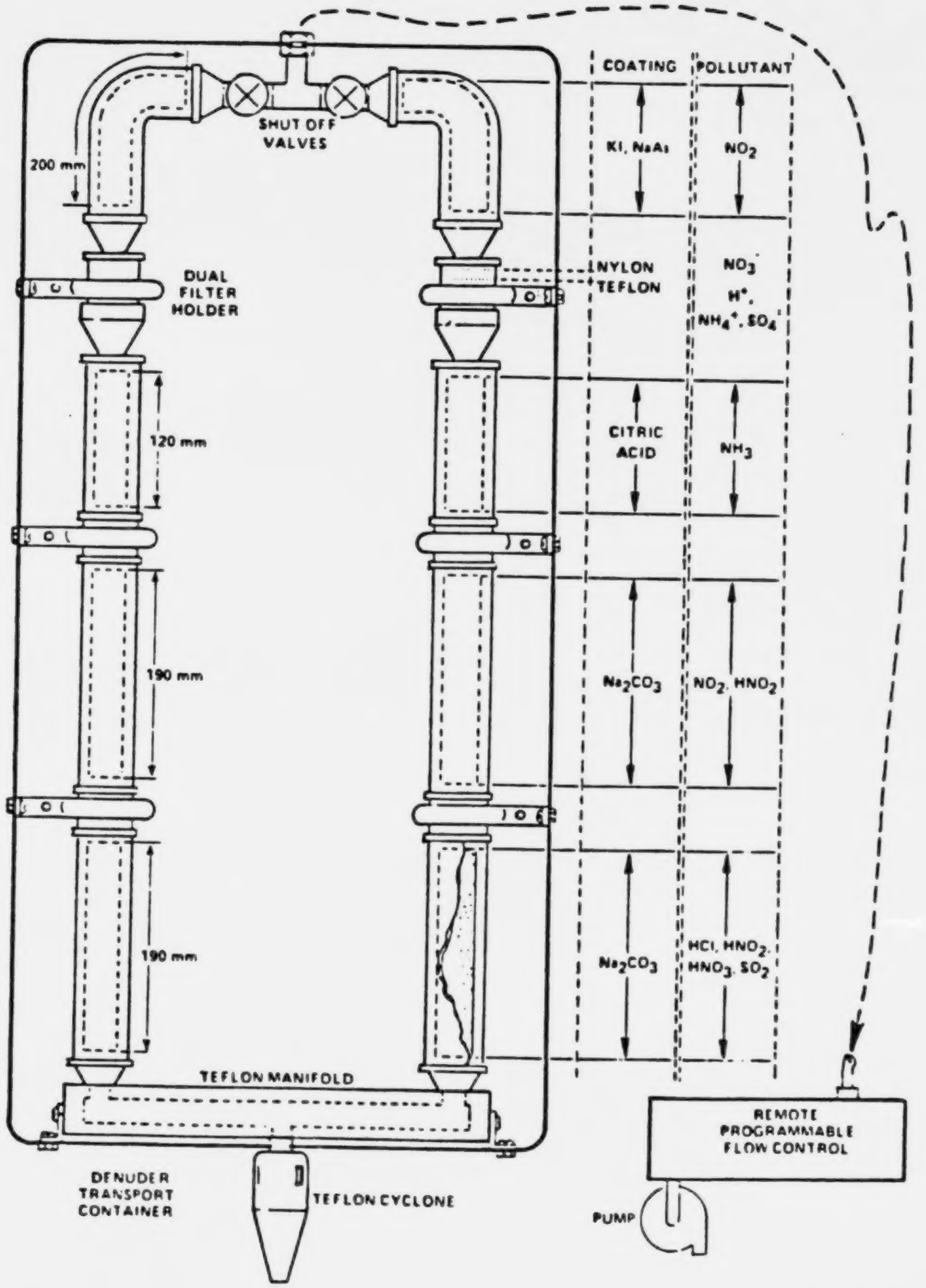

SHUT OFF VALVES
200 mm
DUAL FILTER HOLDER
120 mm
190 mm
190 mm
TEFLON MANIFOLD
DENUDER TRANSPORT CONTAINER
TEFLON CYCLONE
COATING
POLLUTANT
KI, NaAs
NO_2
NYLON
TEFLON
NO_3^-
H^+,
NH_4^+, $SO_4^=$
CITRIC ACID
NH_3
Na_2CO_3
NO_2, HNO_2
Na_2CO_3
HCl, HNO_2,
HNO_3, SO_2
REMOTE PROGRAMMABLE FLOW CONTROL
PUMP

Figure 6-8. U.S.-Italy annular denuder acid deposition sampling system.

1. Advantages:

   - -- Avoids problem with gas and particulate phase nitrate by collecting all gas phase nitrates up front.

   - -- Because 99% of the HNO_3 is collected in the denuder, the problem of higher detection limits for HNO_3 found in samplers like the TFR is avoided.

2. Disadvantages:

   - -- Requires considerable technical expertise to assemble and operate.

   - -- Leakage problems.

   - -- Fragile. This system is made of glass. Breakage could be a considerable problem for a large, routine network, both in terms of loss of data and cost of sampler replacements.

   - -- Due to oxidation of NO_2^- to NO_3^- in $NaCO_3$ denuders, the HNO_3 is overestimated and the HNO_2 is underestimated.

   - -- Gaseous NO_2 is an interferent. Approximately 2% of gaseous NO_2 is removed by the denuder and erroneously reported as HNO_2. Even using two denuders in series to correct for the absorption of gaseous NO_2 gives nitrous acid concentrations that many photochemists believe are too high. They don't believe that much nitrous acid is present in the daytime.

6.2.4 Denuder difference method. This method uses two filter packs through which air is pulled at the same flow rate. One filter pack is preceded by a denuder tube made of aluminum to remove HNO_3 and is used to determine particulate nitrate. The difference between the two filter packs is used to determine HNO_3.

1. Advantages:

   - -- Excellent method for particulate NO_3.
   - -- Avoids problem with gas and particulate phase NO_3.
   - -- Simple to operate.

2. Disadvantages:

   - -- HNO_3 data may not be reliable. When the gas to particle ratio is low, the differences between the two filter packs will be very small and subject to error.

6.2.5 Quality control. Quality control activities associated with field use of integrated samplers include:

- -- Calibration of the sampler's flow controls on a regular schedule (e.g., quarterly).

-- Leak checking the system on a regular schedule. This is usually done during sample changeout.

-- Following standard practices to avoid contamination of the sampler (e.g., wearing powder-free plastic gloves during changeout, storing all samples in a contaminant free environment).

-- Adherence to the project SOP for integrated sampler operation.

6.2.6 Special considerations. Flow devices (e.g., laminar flow elements, flowmeters) used to calibrate monitoring site flow controllers must be calibrated in the same way they will be used in the field. For example, do not take a flow device that has been calibrated with one end open to the atmosphere and use it in a closed system to calibrate flow. It must be used with one end open to the atmosphere. Violation of this rule can introduce significant errors in flow rate calibrations.

6.3 Continuous Monitors

Continuous monitors are used to collect real-time data. Collection of real-time data is particularly useful to dry deposition projects that are concerned with episodic events or peak concentrations of pollutants (e.g., terrestrial effects researchers). Continuous monitors are being used in monitoring projects to measure:

-- Ozone (O_3)
-- Sulfur dioxide (SO_2)
-- Nitrogen dioxide (NO_2)

1. Advantages:

-- Versatility of collected data

- Hourly, daily, weekly averages can be calculated

- Peak concentrations, low concentrations, and time of occurrence are readily available

-- Requires minimal laboratory support

- Routine instrument calibration

2. Disadvantages:

-- Initial cost

-- Unavailability of calibration standards at appropriate concentration levels (e.g., NBS SRM's)*

-- Unavailability of field tested monitors capable of measuring pollutants at low or sub ppb concentrations*

*NOTE: Tremendous strides have been made in the last few years to correct these deficiencies.

6.3.1 Special considerations.

-- Monitors should be calibrated in the concentration range being monitored (e.g., an SO_2 monitor calibrated at 250, 500, and 1000 ppb might not give reliable, detectable data at low ppb levels).

-- Always check for excess flow of calibration gas during calibration of site monitors. One way to check for excess flow is to connect a rotameter to the site instrument vent. Excess flow will cause the rotameter ball to rise in the tube. Insufficient flow during calibration will cause the site instrument to overestimate pollutant concentrations during routine operation.

-- Always check transfer standards or calibration equipment against a primary standard before taking it to the field to calibrate site equipment. (This equipment should be rechecked when site calibration is completed to ensure nothing has changed.)

-- Be aware of potential problems when using monitoring equipment at high elevations. Appropriate corrections for barometric pressure and procedures should be included in SOP's.

6.3.2 Quality control. Quality control activities generally associated with continuous monitors are:

-- Calibration of the monitor on a regular schedule (e.g., quarterly).

-- Zero, span, and precision check of the instrument on a regular schedule (e.g., weekly).

-- Performance of routine instrument maintenance (e.g., replace filters, replace chemical scrubbers for zero air).

-- Adequate documentation of all instrument calibrations, repairs, maintenance, etc.

-- Adherence to the project's SOP for instrument operation.

6.4 Meteorological Systems

Meteorological conditions play an integral part in the calculation of deposition velocities. Meteorological (MET) systems used in dry deposition monitoring projects should:

- -- Be rugged
- -- Be reliable
- -- Require little maintenance
- -- Meet the project's quality objectives and needs

MET monitoring systems generally consist of sensors mounted on a tower (e.g., wind sensor) or other supports (tipping bucket) at a specified height (e.g., wind speed and direction at 10 meters). Monitoring heights are project specific. These sensors are usually interfaced to an electrical signal translator housed in the site shelter. The meteorological translator is an intermediate stage that takes the electrical signals coming from the sensors, amplifies them and sends them to the appropriate channel of the data acquisition system (DAS) for collection, reduction, and storage. Meteorological parameters commonly measured are wind speed, wind direction, sigma theta, temperature, delta temperature, relative humidity or dew point, solar radiation, precipitation, and surface wetness.

6.4.1 Wind speed. Wind speed is usually measured with a 3-cup anemometer or propeller anemometer which rotates as the wind blows. The rate of rotation (rpm) increases with increasing wind speed. Transfer functions (conversion factors) are provided by the manufacturer to convert rpm to wind speed.

6.4.1.1 Special considerations. To ensure proper operation of the wind speed sensor, the sensor should be routinely checked for:

- -- Bearing wear. Worn bearings are one of the major causes of poor anemometer operation. A quick check for this is to visually observe the anemometer rotation during a period when the wind is barely blowing. If the anemometer does not slowly rotate, the bearings are probably going bad and more comprehensive checks on the bearing condition should be made.

- -- Physical damage. MET equipment is subject to physical damage caused by hunters using it for target practice, birds using it for perches, and exposure to the environment.

    - -- Cups and propellers should be checked for dents.

    - -- Anemometers should be checked for bent arms or loose or damaged propeller blades or cups. Any damaged parts should be replaced. All repairs should be documented in the site logbook.

6.4.2 Wind direction. Wind direction is usually measured by a flat fin that is constantly aligning itself into the wind. This fin is usually connected to a potentiometer, which converts a change in resistance to a particular wind direction. Wind direction sensors should be aligned to true north (not magnetic north).

6.4.2.1 Sigma theta. Sigma theta is the standard deviation of wind direction.

6.4.2.2 Special considerations. To ensure proper operation of the wind direction sensor, it should be routinely checked for:

-- Physical damage. Check the fin for pits, dents, or bends.

-- Alignment. Check to see that the fin is pointing in the right direction. One way is to visually determine wind direction and then look to see if the fin is aligning itself into the wind. If improper alignment is observed, bad bearings may be the cause.

-- Potentiometer operation. Use a voltmeter to check the potentiometer.

-- Balance. Remove the fin and lay it on its side. The tail and nose of the fin should remain level. If the tail or nose goes down, it is not balanced.

Damaged or improperly working parts should be replaced. All repairs should be documented in the site logbook.

6.4.3 Temperature (T, ΔT). Temperature is measured with a thermistor or a platinum resistance thermometer. Resistance in both of these devices changes as a function of temperature. To measure temperature in the atmosphere accurately, an adequate ventilation rate and appropriate shielding from the sun are essential. Ambient temperature is measured at two different heights, T_1 and T_2. ΔT is the difference between the two temperatures.

6.4.3.1 Special considerations. To ensure proper operation of the temperature sensors:

-- Always use radiation shields on the sensors.

-- If an aspirated shield is used, check to be sure the fan motor is working.

-- Check inside the radiation shield for bugs, spiders, spider webs, etc. If necessary, clean the shield.

6.4.4 Dew point. The dew point sensor measures resistance and consists of a thermistor covered with a lici-coated muslin sock which is heated by a 25-volt AC wire. As the sock absorbs water, the temperature changes. This change in temperature is picked up by the thermistor which converts the change in resistance to dew point temperature.

6.4.4.1 Special considerations. To ensure proper operation of the dew point sensor:

-- An adequate ventilation rate and appropriate shielding from the sun are essential.

-- Check to be sure the fan motor in the aspirated shield is working.

-- Make sure the muslin sock is not dirty. Dirt on the sock will adversely affect dew point readings.

-- Check inside the radiation shield for bugs, spiders, spider webs, foreign matter, etc. If necessary, clean the shield.

-- Allow the dew cell adequate time to stabilize after a power failure.

6.4.5 Relative humidity (RH). The RH sensor measures changes in the capacitance of a polymer which is sensitive to water vapor. The change in capacitance is detected by the sensor and converted into % RH. RH sensors generally operate well between 5% to 95% RH.

NOTE: An inherent property of the RH sensor -- When there is a low wind speed combined with lots of dew on the ground or fog, RH values will be above 100% due to saturation of the polymer.

6.4.5.1 Special considerations. To ensure proper operation of the RH sensor:

-- An adequate ventilation rate and appropriate shielding from the sun are essential.

-- Check inside the aspirated shield for bugs, spiders, foreign matter, etc. If necessary, clean the shield.

-- Check to be sure fan motor in aspirated shield is working.

-- Make sure the porous polymer sensor is not dirty. Dirt on the sensor will adversely affect RH readings.

6.4.6 Solar radiation. Solar radiation is measured by a sensor containing a photodiode or a thermopile that converts sunlight into voltage. This voltage is converted into units of energy (watts/m^2) using a calibration factor supplied with the instrument.

6.4.6.1 Special considerations. To ensure proper operation of the solar radiation sensor:

-- Routinely check the sensor for physical damage (cracked globe, scratched globe, discolored disk, etc.).

-- Check the globe for dirt or foreign matter. Clean if necessary. Proper cleaning procedures are important to avoid scratching the globe.

-- Make sure the sensor is level.

-- Make sure the sensor is not shaded during any period of the day.

6.4.7 Tipping bucket. The tipping bucket is used to measure precipitation (rain, snow, sleet). It consists of a housing of known diameter that funnels collected precipitation to a seesaw-type tipping arm. Every time the tipping arm collects 0.01 inches of rain, it tips to the other side contacting a reed switch. The signal from the contact closure of the reed switch is sent to the data acquisition system (DAS) where precipitation events and amounts are recorded.

6.4.7.1 Special considerations. To ensure proper operation of the tipping bucket sensor:

-- Routinely (e.g., weekly) check the tipping bucket for damage (corroded reed switch, loose wires, etc.).

-- Manually tip the tipping arm and compare manual tips with those recorded on the DAS. The arm should not be tipped rapidly; too rapid tipping will not allow the system to record tips accurately.

-- Check the tipping bucket for dirt, foreign matter, spider webs, etc., that might interfere with its collection efficiency or tipping action.

-- Make sure the tipping bucket is level.

6.4.8 Surface wetness sensor. The wetness sensor measures surface wetness by changes in either capacitance or resistance. Water or moisture collecting on the sensor surface causes a change in the sensor's capacitance or resistance. This change is recorded by the DAS as surface wetness.

6.4.8.1 Special considerations. To ensure proper operation of the wetness sensor:

-- Placement of the sensor is extremely important. The sensor should be kept at the height of the canopy of interest. That is for:

-- Forest - Sensor should be located near tops of trees.
-- Grass - Sensor should be located near top of grass.

-- Make sure the sensor is pointed to the north. For vegetation, it should be tilted slightly down.

-- Routinely check sensor surface for dirt, foreign matter, etc. Clean if necessary.

-- Routinely spray water on sensor surface to check for proper response.

6.4.9 Quality control. Quality control activities generally associated with meteorological equipment are:

-- Calibration of MET equipment on a regular schedule (e.g., quarterly). Any equipment found operating outside the project's acceptable limits should be repaired or replaced. Out-of-spec equipment should be sent to the manufacturer for recalibration (when necessary).

-- Zero and span checks of the MET equipment on a regular schedule (e.g., weekly). Zero and span checks on MET equipment only check the electronics of the system and should not be equated with physical checks of the system performed during calibrations and audits.

-- Performance of routine maintenance (e.g., replacement of worn bearings, etc.).

-- Documentation of all sensor calibrations, repairs, maintenance, etc.

-- Performance of routine checks and tests to ensure the sensors are operating properly. This would include the tests and checks discussed under each sensor type in Sections 6.4.1.1, 6.4.2.2, 6.4.3.1, 6.4.4.1, 6.4.5.1, 6.4.6.1, 6.4.7.1, and 6.4.8.1.

-- Adherence to the project's SOP for meteorological equipment operation.

6.5 Data Acquisition System

The data acquisition system (DAS) is the means employed by a monitoring project to physically collect and store the data being generated by the site's monitoring equipment. These systems vary from simple to complex. One of the simplest systems is the collection of monitoring data on a chart recorder. Although this collection and storage system is simple, the task of taking data from the charts, manually compiling it, and entering it into the data base is labor intensive. Most monitoring projects today use electronic data acquisition systems. These systems are capable of taking many readings in a few seconds and reporting the results in a pre-selected format, such as 5-minute or hourly averages. Most systems store collected data on a removable cartridge (tape, EEprom, etc.). This cartridge can be removed from the DAS and sent to the central laboratory where the data is transferred to the data base. Some data acquisition systems are interfaced with a PC and modem so data can be sent to the laboratory electronically or down-loaded to a disk and sent to the laboratory. When operating properly, electronic data acquisition systems reduce the number of errors and hours involved in the extraction, compilation, and entry of data into the data base.

Each monitoring site must have two completely independent data acquisition systems. One of these is the primary system; the other is a back-up system in case the primary system fails. Many projects use an electronic DAS for the primary system and chart recorders for the back-up system.

The data acquisition system (DAS) needed to meet a project's needs are project specific and depend on budgets, project duration, type of samples being collected, etc. General areas of consideration in selecting a DAS are:

-- The project's quality objectives and needs.

-- Comparison of skills needed to operate the DAS with the skill level of the site operators.

-- Ruggedness and reliability.

-- Cost.

-- Data capacity.

-- Number of data channels.

-- User friendliness.

6.5.1 Quality control. Quality control activities usually associated with the data acquisition system include:

-- Protection of data collection with a fully functional back-up system to prevent data loss if the primary system fails.

-- Routine check-out of the system (e.g., quarterly). All instrument calibrations should include a comparison of the instrument output with the DAS output.

-- Routine maintenance.

-- Documentation of all repairs, program changes, audits, etc.

-- Adherence to the project's SOP for system operation.

-- Routine (quarterly) comparison of a predetermined amount (5%) of data collected by the primary system to data collected by the back-up system.

6.6 Wet Deposition

Dry deposition monitoring sites not collocated with wet deposition sites often collect wet deposition data. EPA's "Operations and Maintenance Manual for Precipitation Measurement Systems" [EPA 600/4-82-042b (July 1986)] contains detailed information on all aspects of wet deposition site operation. A brief outline of site operations and quality control procedures is given below with references to more details in the Operations and Maintenance (O&M) Manual mentioned above.

6.6.1 Site operations for wet deposition. Operation of a precipitation collection site encompasses four major areas.

1. Equipment operation and maintenance
2. Sample collection, handling, measurement, preservation, storage, and equipment

3. Documentation of field activities
4. Quality control procedures

Precipitation samples are very dilute. Large measurement errors can occur because of contamination or degradation. Field procedures must be accomplished in a way that ensures measurement accuracy.

A precipitation collector and recording rain gauge are the major items of equipment installed at a site. Additionally, certain other equipment and supplies are needed to support the site. Table 2-1 of the O&M Manual gives a list of needed supplies and suggested quantities for a single site, and supplies to support a 10-12 station network are shown in Table 2-2.

The precipitation collector should be mounted on the ground so that the rims of the buckets are level and at least 1 m above the ground. The collector should be properly anchored against strong winds, and the bucket should be secured to the precipitation collector. Section 2.2 of the O&M Manual presents a thorough discussion of the installation of the collector and the operational checks to be performed, such as lid cycling test, moisture sensor, lid seal, maintenance and troubleshooting. It would be useful for even an experienced operator to refer to Section 2 of the O&M Manual when installing and checking out the collector. The operator should also be familiar with the maintenance manual supplied by the manufacturer. The manual for the Aerochem Metrics precipitation collector is reproduced in Appendix A of the O&M Manual.

The recording rain gauge is installed to measure the quantity of precipitation. The gauge should be capable of measuring to approximately 0.25 mm (0.01 inch). Section 2 of the O&M Manual details the selection, description, and installation of the rain gauge. The operator should be familiar with the instruction book supplied with the rain gauge. The manual for the Belfort universal recording rain gauge is reproduced in Appendix B of the O&M Manual.

The precipitation samples are collected in polyethylene buckets, plastic bag bucket liners, or plastic bottles. A discussion of collection and handling procedures is presented in Section 2.4 of the O&M Manual.

The measurement procedures for weighing, pH, and conductivity should be identical with those used by the central laboratory. If sufficient sample (more than 70 g) is available, its pH and conductivity are measured both in the field laboratory and at the central laboratory. If less than 70 g of sample is collected, the sample is sent to the central laboratory without measuring pH and conductivity. The methods for measuring sample weight, pH and conductivity are presented in Section 2.5 of the O&M Manual.

The collected samples must be adequately identified so that they can be readily and correctly matched with their data forms. The sample label should contain site identification, sampling period, and sample weight. These items are covered in detail in Section 2.6 of the O&M Manual.

All data, observations, and any changes must be documented on the field report form and in site logbooks. The rain gauge charts should be submitted weekly to the central laboratory. The field report form should contain all of the following information: operator, date, sample weight, sampling times, field values for pH and conductivity, and any problems encounterd. An example of a field report form is shown in Section 6.1, Figure 6-2, of this manual.

6.6.2 Quality control. Quality control procedures used to help assure the collection of high-quality precipitation data include:

-- Complete documentation of all observations and measurements.

-- Use of known test solutions for pH and conductivity tests.

-- Recheck of pH calibration after sample measurements.

-- Adherence to the project's SOP for wet deposition sample collection and field analysis.

6.7 Training

Because site operation is the single most important determinant of data quality, it is essential that site operators be familiar with and well trained in site operation procedures. Section 7.0 of this manual describes operator training in detail.

6.8 QA's Role in Site Operations

Quality assurance activities during the initial phases of the monitoring project include ensuring that:

-- SOP's for all site operations (equipment operation, sample changeout, etc.) are accurate and meet the project's needs.

-- Adequate QC tests and checks are included in all phases of site operations to ensure project quality objectives and needs are being met.

-- Monitoring methods used will produce data meeting the project's quality objectives and needs.

-- Documentation procedures for site operations are well defined and meet the project's needs.

-- Calibration procedures for site equipment are documented in accurate SOP's and meet the project's needs.

-- Acceptance and validation criteria are well defined for all site operations (e.g., ozone data must be ±10%, night solar radiation values are zero, etc.).

-- The calibration schedule for monitoring equipment is adequate to meet the project's needs.

Once the monitoring site is operating in a routine manner, quality audits of site operations are conducted on a regular schedule (e.g., every 6 months) to assure generated data:

-- Is of defined quality, and
-- Meets the needs of the project.

Both systems and performance audits are conducted routinely at each monitoring site.

6.8.1 Systems audits. A systems audit of each monitoring site's operation is conducted at site initiation and then on a regular schedule (e.g., annually) for the life of site operations. The systems audit is used to verify that:

1. The site is operating in a timely, efficient, well-documented manner consistent with the project's objectives.

2. The quality control (QC) procedures specified for each measurement process or system are performed in a timely manner and in conformance with the criteria specified in the SOP's.

3. The QC procedures specified for site operations are adequate to assure the collected data meets the project's quality objectives and needs.

4. The monitoring site is responding to and meeting the project's needs in a timely manner (i.e., sample changeout is done on schedule, timely reporting of instrument failure or other operational problems; collected samples are shipped to the laboratory on schedule, etc.).

Listed below are activities usually audited during a monitoring site systems audit and some sample questions that would be asked about each activity.

1. Organization and responsibilities. What are the site operator's responsibilities? Who does the operator report to? Who gives the operator instructions regarding: changes in procedures, scheduled calibrations, audit dates, etc.? How often is the site visited? Is anyone giving conflicting instructions?

2. Document control/documentation. Are all activities associated with site operations well documented (SOP's, instrument manuals, etc.)? Are these documents available? Are they kept up to date? How is this done? Are recordkeeping activities being performed? Are they done in a manner consistent with the SOP for the activity? Can the site operator retrieve needed information (e.g., date of last ozone calibration, site description information, control charts) in a timely, efficient manner? Are site logbooks, records, and files kept in a manner consistent with the project's SOP for site operation?

3. Training. How are site operators trained? How often is training given? What measures are taken to ensure training is adequate? Who did the training? What did the training consist of? Is there any follow-up to the training? If so, what kind? What was the date of the operator's last training?

4. Sampling procedures. Are SOP's available for all monitoring procedures? Are they accurate? Are they being followed? What pollutants are being monitored? How is the data collected? How is it processed? Where are collected samples, data sheets, etc., sent? How often are samples collected? How often are samples sent to the laboratory for analysis? How is the collected data quality assured? How are samples labeled? What forms accompany samples to the laboratory? Are checksheets routinely filled out by the operator? How often? What information is requested? How often does the operator report site status to the central laboratory? How is this done?

5. Sample custody. What sample custody procedures are followed by site personnel? Are these procedures documented? How?

6. Calibration procedures. How often is the site's monitoring equipment calibrated? What is calibrated? What procedures are followed? Is an SOP available? Is it accurate? Is it being followed? Who calibrates the equipment? Are the transfer standards, etc., used for calibration traceable to a primary standard (NBS when possible)? Where are calibration records kept? Are they accurate and adequate? Do they include calibration date, equipment calibrated, calibration curves, personnel doing calibrations, etc.?

7. Siting criteria. Is a site description available? Is it accurate? How often is it updated? Does the site meet the project's siting criteria? Are any deviations from these criteria included in the site description? How does the site evaluation performed as part of the systems audit compare with the site description on file at the site?

8. Data reduction, validation, and reporting. What type of data acquisition systems is used by the site? Is there an SOP for data collection and storage? Is it accurate? Is it adequate? Is it being followed? How is collected data stored? Is any data validation done at the site? If so, what kind? Is there an SOP for data validation? Is it accurate? Is it adequate? Is it being followed? How is collected data reported to the central laboratory (mail, modem, etc.)? It there an SOP for this?

9. Maintenance. What type of maintenance is performed? Is there a written procedure for it? Where are the maintenance records kept? Are they accurate and adequate? Do they list maintenance performed, date performed, personnel performing the maintenance, etc.? Is there a maintenance checklist?

10. Corrective action. How are problems identified? How are they reported? Who is responsible to see corrective action is taken? Is there a form for reporting problems? How are responses to corrective action requests tracked?

The systems audit of monitoring site operations is an intense review of all site activities. Because of the audit's complexity, an audit questionnaire or checksheet is usually used to guide the auditor through each area of interest. For the systems audit to be effective, each monitoring project must develop audit procedures and questionnaires that specifically address their project's activities. The preceding discussion of activities usually included in a monitoring site systems audit; the NDDN field systems audit report form in Appendix G; the field portion of the systems audit questionnaire used in the MCCP in Appendix I, and the systems audit portions of the NADP/NTN systems and performance survey questionnaire in Appendix J can serve as guides in the development of project specific audits.

6.8.2 Performance audits. Performance audits of monitoring site operations are usually conducted on a routine schedule (e.g., semiannually). These audits verify that the data being collected at the site meets the project's data quality requirements and needs. Site performance is usually evaluated by:

1. Challenging site monitors (e.g., ozone, SO_2) with known pollutant concentrations. Site monitor performance is determined from a comparison of the pollutant concentrations recorded by the site monitor with the known audit concentration.

2. Physically manipulating site monitoring equipment by turning, pointing, etc., at known speeds, directions, etc. (e.g., pointing wind direction fin at a known directional target). The site monitor outputs determined during manipulation are compared to the known audit inputs to determine performance.

3. Collocation of an audit transfer standard with the site sensor (e.g., solar radiation). Site performance is determined from differences between the two sensors.

Table 6-3 outlines the performance tests and criteria used in auditing NADP/NTN sites.

Performance audit procedures are project specific. Site equipment usually audited includes:

-- Continuous monitors (O_3, SO_2, NO_2)

-- Flow controllers for integration samplers

-- Meteorological equipment
    -- Wind speed
    -- Wind direction
    -- RH or dewpoint

Table 6-3. NADP/NTN Site Measurements and Performance Survey Methods

Site measurement	Measurement device	Performance survey method	Designated performance criteria
Rain depth	Rain gauge (Belfort)	Challenge with known weights that simulate rainfall.	Agreement within ± 0.1 inch of test weight value over the range 0-12 inches.
Precipitation sample collection	Precipitation collector (Aerochem Metrics)	Measure resistance across sensor, measure tension and drop bucket lid, measure temperature and voltage of activated sensor.	Resistance in range of 60-90 K. Lid drop distance >3 mm. Sensor temperature ambient prior to activation; temperature of 50-79°C after activation.
Mass	Triple beam balance	Challenge with traceable weights.	Agreement within ± 5 g of test weight value.
pH	pH meter and electrode	Challenge with simulated precipitation sample of known pH.	Agreement within ± 0.1 pH unit of test solution's designated value.
Conductivity	Conductivity meter and cell	Challenge with simulated precipitation sample of known pH.	Agreement within ± 4 µS/cm of test solution's designated value.

    - Temperature
    - Delta temperature
    - Solar radiation
    - Rain gauge (tipping bucket)

- Wet deposition equipment
    - Wet-dry collector
    - Rain gauge (weighing type)

Each project must develop a comprehensive set of project specific audit procedures for all pollutants and parameters being measured. These SOP's must include pollutant and parameter performance standards that meet the project's data quality objectives and needs. Section 8.5.2 on the development of SOP's and the sample SOP's listed below can be used as guidelines in developing project SOP's:

- SOP for Performance Auditing Meteorological Instruments at Dry Deposition Monitoring Sites (Appendix K)

- SOP for Performance Auditing Ozone Analyzers at Dry Deposition Monitoring Sites (Appendix L)

- SOP for Performance Auditing SO_2 Analyzers at Mountain Cloud Chemistry Monitoring Sites (Appendix M)

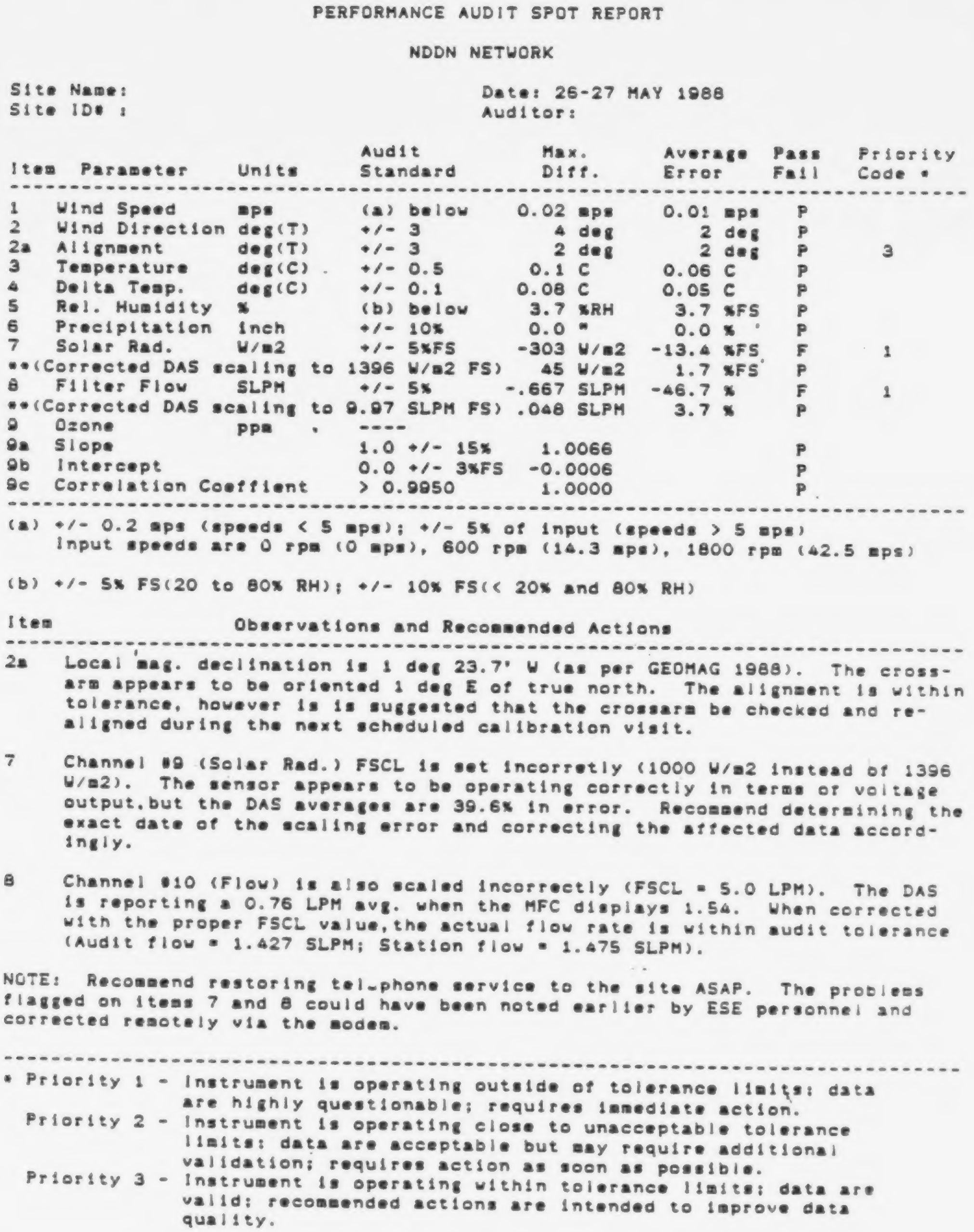
6.8.3 Quality audit results. Quality audits (systems and performance) are conducted to verify that site operations are functioning in a manner consistent with the quality objectives and needs of the project. Any deviations from standard procedures, exceedances of operating limits (criteria), etc., are to be brought to the attention of project management for immediate investigation and correction. Some corrective actions typically found in monitoring projects are:

- Retraining or reinstruction
- Revision of SOP's to clarify procedures or reflect procedures being used
- Recalibration of equipment and monitors
- Replacement or repair of faulty equipment or monitors

Auditors usually give a verbal report or send a brief summary of audit results to project management at the conclusion of the audit. Figure 6-9 shows an example of the brief audit report used for NDDN audits. This report is sent to project management within 24 hours of the audit. A detailed written report must follow within a reasonable time frame (about 2 weeks).

6.8.4 Special considerations. Adherence to the following guidelines will help improve audit quality.

1. Know your equipment. The auditor should be familiar with all aspects and limitations of the audit equipment and the equipment to be audited.



PERFORMANCE AUDIT SPOT REPORT

NDDN NETWORK

Site Name: Date: 26-27 MAY 1988
Site ID# : Auditor:

Item	Parameter	Units	Audit Standard	Max. Diff.	Average Error	Pass Fail	Priority Code *
1	Wind Speed	mps	(a) below	0.02 mps	0.01 mps	P	
2	Wind Direction	deg(T)	+/- 3	4 deg	2 deg	P	
2a	Alignment	deg(T)	+/- 3	2 deg	2 deg	P	3
3	Temperature	deg(C)	+/- 0.5	0.1 C	0.06 C	P	
4	Delta Temp.	deg(C)	+/- 0.1	0.08 C	0.05 C	P	
5	Rel. Humidity	%	(b) below	3.7 %RH	3.7 %FS	P	
6	Precipitation	inch	+/- 10%	0.0 "	0.0 %	P	
7	Solar Rad.	W/m2	+/- 5%FS	-303 W/m2	-13.4 %FS	F	1
**(Corrected DAS scaling to 1396 W/m2 FS)				45 W/m2	1.7 %FS	P	
8	Filter Flow	SLPM	+/- 5%	-.667 SLPM	-46.7 %	F	1
**(Corrected DAS scaling to 9.97 SLPM FS)				.048 SLPM	3.7 %	P	
9	Ozone	ppm	----				
9a	Slope		1.0 +/- 15%	1.0066		P	
9b	Intercept		0.0 +/- 3%FS	-0.0006		P	
9c	Correlation Coeffient		> 0.9950	1.0000		P	

(a) +/- 0.2 mps (speeds < 5 mps); +/- 5% of input (speeds > 5 mps)
Input speeds are 0 rpm (0 mps), 600 rpm (14.3 mps), 1800 rpm (42.5 mps)

(b) +/- 5% FS(20 to 80% RH); +/- 10% FS(< 20% and 80% RH)

Item	Observations and Recommended Actions
2a	Local mag. declination is 1 deg 23.7' W (as per GEOMAG 1988). The cross-arm appears to be oriented 1 deg E of true north. The alignment is within tolerance, however is is suggested that the crossarm be checked and re-aligned during the next scheduled calibration visit.
7	Channel #9 (Solar Rad.) FSCL is set incorretly (1000 W/m2 instead of 1396 W/m2). The sensor appears to be operating correctly in terms of voltage output,but the DAS averages are 39.6% in error. Recommend determining the exact date of the scaling error and correcting the affected data accordingly.
8	Channel #10 (Flow) is also scaled incorrectly (FSCL = 5.0 LPM). The DAS is reporting a 0.76 LPM avg. when the MFC displays 1.54. When corrected with the proper FSCL value,the actual flow rate is within audit tolerance (Audit flow = 1.427 SLPM; Station flow = 1.475 SLPM).

NOTE: Recommend restoring tel-phone service to the site ASAP. The problems flagged on items 7 and 8 could have been noted earlier by ESE personnel and corrected remotely via the modem.

* Priority 1 - Instrument is operating outside of tolerance limits; data are highly questionable; requires immediate action.
Priority 2 - Instrument is operating close to unacceptable tolerance limits; data are acceptable but may require additional validation; requires action as soon as possible.
Priority 3 - Instrument is operating within tolerance limits; data are valid; recommended actions are intended to improve data quality.

Figure 6-9. NDDN performance audit spot report.

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2. Never assume anything. When a piece of equipment or a monitor fails to pass a performance test:

   -- Check connections, equipment setup, etc., for proper installation.

   -- Rerun the test.

   -- If the test is still not passed, then the performance results can be reported as being outside the tolerance limits.

3. Never rush your audits. Quality auditing of monitoring projects should be done in a careful, methodical manner.

   -- Audit equipment should be given adequate warm-up time before use.

   -- Temperature baths should be at equilibrium before measurements are taken. Rapidly changing temperatures or unequilibrated mixtures of ice and water will give erroneous results.

4. Mimic site data collection procedures. Whenever possible, audit data should be collected in the same way that site data is collected. For example, if the site is collecting 5-minute averages for meteorological data, don't try to take instantaneous readings. Take 5-minute averages, even if it means taking a manual reading every 10-15 seconds for 5 minutes and averaging them. This avoids unexpected problems by averaging out data variability and eliminating the problem of trying to obtain instantaneous readings from both the DAS and audit equipment.

6.9 Summary

As the source of all collected data, monitoring site operation is the single most important factor affecting data quality. It is essential that the monitoring sites not only operate smoothly and efficiently, but that the collected data meet the quality objectives and needs of the project. To ensure data quality, the monitoring site must:

-- Be operated by trained site operators

-- Be operated in strict compliance with site operation SOP's

-- Incorporate adequate QC activities in all site operations

-- Be systems and performance audited on a regular schedule

7.0 TRAINING

Probably the single most important factor affecting the data quality of a monitoring project is the site operator. The comparability, completeness, and quality of the data are affected by: (1) how consistently site operation SOP's are followed; (2) how effectively sample contamination is avoided, and (3) how observant and conscientious the site operator is.

The most effective method to ensure competent, efficient site operation is through training. Depending on the size of the monitoring project, effective training can be accomplished through one-on-one site operator training at the monitoring site, a formal site operator training course at a central location, or a combination of the two. The method employed is not as important as the outcome: a well-trained, effective operator. The more responsibility given the operator, the more intensive the training will be. Four basic elements that should be included in the site operator training are:

1. An overview of the project objectives. The operator should have a basic understanding of what the monitoring project's objectives are, how these objectives will be met, and how important his job is to the mission of the program.

2. Routine site operation. The site operator should have a thorough understanding of and hands-on experience in all aspects of site operation including:

-- Operation of all monitoring equipment (e.g., ozone monitor, filter packs, wet/dry sampler).

-- Operation of the data acquisition system (DAS).

-- Procedures for sample change-out and for shipment of all samples and data collection forms to the central laboratory (e.g., down-loading computer data to disks, filter pack changeouts, pH and conductivity tests of wet samples).

-- Procedures for documentation of site activities (e.g., logbooks, status forms).

-- Recognizing the difference between normal and non-normal (deviant) equipment performance and the proper response to the latter (e.g., repair, report).

-- Maintenance procedures for site equipment.

-- Procedures for communicating with the central laboratory about site conditions, routine operations, supply needs, etc.

-- Procedures for general site housekeeping and shelter maintenance.

-- Station organization and recordkeeping.

3. Non-routine procedures. The site operators need to be given enough information about equipment operation to enable them to make non-routine repairs and equipment adjustments after consulting with appropriate project personnel (e.g., project officer or manager).

The amount of time spent in operator training will be dependent on the complexity of the monitoring equipment and the amount of responsibility (field analysis of samples, repair of equipment, etc.) assigned to the operator. The expenditure of time and effort in effective training of monitoring personnel will more than pay for itself in the collection of data that is complete, comparable, and of high quality.

4. Follow-up program. An effective follow-up program for operator training is needed to ensure the site operator is functioning in an acceptable manner, consistent with the site operation SOP's. A visit by trained project personnel to the monitoring site to observe the newly trained operator perform routine site activities and clarify any questions about site operation should occur within a few weeks after training.

Adequate training for all project personnel (e.g., laboratory analysts, data managers, etc.) is essential to the success of the monitoring project. It should include intense training like that outlined for site operators, but in areas related to their specific project duties.

7.1 QA's Role in Training

Quality assurance activities include ensuring that training is:

-- Available
-- Effective
-- Meets project's needs
-- Documented

This is accomplished by ensuring adequate training for site operators, auditors, etc., is included in the monitoring project's design stage. Once the monitoring project is implemented and operating routinely, adequacy of training is verified through routine systems audits of laboratory and field operations. During these routine audits, laboratory personnel and site operators are evaluated on:

-- Operating/analysis procedures
-- Recordkeeping procedures
-- Documentation of project activities
-- Availability of documents (SOP's, instrument manuals, etc.)

-- Conformance to standard operating procedures (SOP's)
-- Training received

Examples of typical field and laboratory systems audit questionnaires are given in Appendices G, H, I, and J.

7.2 Summary

The success of a dry deposition monitoring project depends upon having a well-trained, organized, competent, professional staff to operate the monitoring sites, analyze collected samples, validate collected data, and maintain a validated data base. The best way to achieve this goal is to make training an integral part of the monitoring project's activities. Quality assurance activities associated with training are to verify through systems audits that training is available, effective, and meets the needs of the project.

8.0 LABORATORY OPERATIONS

The central laboratory is the focal point for site operations. As such, it houses both laboratory operations and data management activities (see Section 9.0). The type of laboratory support needed to operate a dry deposition monitoring project depends on the monitoring methods selected. A monitoring project collecting meteorological and continuous ozone data would need laboratory support in the areas of site supplies, data management, and instrument calibration. A monitoring project collecting meteorological, continuous ozone, Canadian filter pack, and precipitation data would require a great deal of laboratory support: site suppies, filter pack preparation, instrument calibration, sample analysis, data management, etc. Although site activities determine specific laboratory response, these responses generally fall under one of six standard laboratory operations.

1. Acquisition and testing of materials.
2. Preparation and shipment of sampling equipment and supplies.
3. Receipt and log-in of samples.
4. Preparation and storage of samples for analysis.
5. Analysis of samples.
6. Validation and transfer of data to the data base.

8.1 Acquisition and Testing of Materials

The central laboratory is responsible for assuring procured chemicals, sampling media (e.g., teflon, nylon, and Whatman filters), etc., meet the project's quality objectives and needs. (Procurement is discussed in Section 4.0.) This is accomplished through acceptance testing of the materials. General activities associated with material testing for monitoring projects are:

1. Random selection of representative samples of test material.

2. Preparation of test material for analysis (e.g., filters are extracted).

3. Analysis of test material for pollutant concentrations of interest (e.g., SO_4^{-2}, NO_3^-, K^+) employing analytical procedures used for project sample analysis.

4. Documentation of results including:

   -- Material lot number
   -- Date of analysis
   -- Analytical results
   -- Acceptability of material for project use

Typical material that would be acceptance tested for use in EPA's NDDN is listed in Table 8.1

Table 8-1. Acceptance Testing of Materials for NDDN

Material	Pollutant analysis
Teflon filter	SO_4^{-2}, NO_3^-, Na^+, K^+, Ca^{+2}, Mg^{+2}, NH_4^+
Nylon filter	$SO_4,^{-2}$, NO_3^-
Whatman 41 filter	SO_4^{-2}, NO_3^-
Sample bottles and bucket liners (for wet deposition collection sites)	Cl^-, NO_2^-, NO_3^-, PO_4^{-3}, SO_4^{-2}, NH_4^+ Ca^{+2}, Mg^{+2}, Na^+, K^+

Material not meeting the acceptance criteria (established during the project planning stage) will not be used for sample collection. Sometimes filter material that does not pass the acceptance test can be washed to remove unacceptable pollutants. The Whatman 41 filters acquired for the NDDN had unacceptable background levels of sulfate and nitrate. To correct this problem, the filters are washed with deionized water to remove unwanted pollutants.

8.1.1 Quality control. Acceptance testing of materials is itself a quality control (QC) activity. However, acceptance data is quality assured by the QC procedures included in the SOP's used for material testing and adherence to the project's SOP for acceptance testing of materials.

8.2 Preparation and Shipment of Equipment and Supplies

Efficient preparation and shipment of sampling equipment and supplies to the monitoring sites is essential to the project's overall operation. The time and energy required to meet the project's needs are variable and depend on the number of sites and the frequency of sampling. A monitoring project collecting daily filter pack samples at 50 sites would require much more sample preparation than a 5-site project collecting weekly filter pack samples. Laboratory support for the preparation and shipment of equipment and supplies can be divided into two major tasks:

1. Preparation of integrated samplers;
2. Packaging and shipment of equipment and supplies.

8.2.1 Preparation of integrated samplers. Integrated samplers which collect gaseous and particulate air samples are widely used for dry deposition monitoring. Examples of this type of sampler are:

-- Transition flow reactor (TFR)
-- Annular denuder
-- Canadian filter pack

Some common characteristics shared by integrated samplers are:

- -- The use of filters, treated filters, or coated surfaces
- -- The need for laboratory support for
  - -- Sampler assembly
  - -- Sample preparation
  - -- Sample extraction
  - -- Sample analysis

The SOP's for preparing integrated samplers for field use are type and pollutant dependent. General activities included in the sample preparation are:

8.2.1.1 Preparation of sampling media. The filters, liners, and denuder tubes used in an integrated sampler must be prepared for sampling. Filters such as the teflon and nylon used in the Canadian filter pack require no additional preparation. The Whatman 41 filters used to collect sulfur dioxide are treated with a potassium carbonate/glycerine solution. The solutions used to treat the filters and liners or coat the denuder tubes are sample type and pollutant dependent. The general activities followed for filter, liner, or denuder treatment are:

- -- Wash the sampling media with appropriate solutions to remove background contaminants. (This step is not always required.)
- -- Treat sampling media or coat denuder tube with appropriate solution. Filters are usually soaked in the treating solution.
- -- Air or oven dry treated sampling media in a contaminant-free environment.
- -- Assign a lot number and store treated media in a labeled, contaminant-free container.
- -- Analyze representative portions of each treated lot for pollutants of interest to assure background concentrations meet the acceptance criteria.
- -- Record analytical results, lot numbers, preparation date, analysis date, and acceptability for use in a sample preparation logbook.
- -- Treated material not meeting acceptance criteria will not be used in the project.

Table 8-2 lists the sampling media preparation used in the EPA ACID MODES field study. Although the information in Table 8-2 was taken from the January 1988 draft of the ACID MODES quality assurance project plan (QAPP) and is subject to change, it is an excellent example of the variety of sampling media and treatment procedures used in dry deposition monitoring.

Table 8-2. Sampling Media Preparation

Sampler type	Sample media	Washed with	Treated with	Analyzed for	Acceptance criteria
TFR	Nylon liner	Carbonate buffer	--	NO_3^-	<0.5 µg/liner
		D.I. H_2O rinse			
	Nafion liner	Acid	--	NH_4^+	<3.0 µg/liner
Filter pack	Teflon	--	--	SO_4^{-2} NO_3^-	<1.0 µg/filter <1.0 µg/filter
	Nylon	Carbonate buffer	--	SO_4^{-2}	<1.0 µg/filter
		D.I. H_2O		NO_3^-	<1.0 µg/filter
	Whatman 41	--	Citric acid/ glycerin solution	NH_4^+	<1.0 µg/filter
	Whatman 31 ET chrome	--	TEA,[1] glycerin, acetone solution	NO_2^- NO_3^-	<1.0 µg/filter <1.0 µg/filter

[1] Triethanolamine

8.2.1.2 Preparation and assembly of integrated samplers. General activities associated with the preparation and assembly of integrated samplers are:

1. Cleaning the integrated sampler parts. Although specific procedures differ for each sampler type, most include cleaning the sampler parts with a brush or in an ultrasonic bath, rinsing them with copious amounts of D.I. water, air or oven drying, and storage in a resealable plastic bag until needed.

2. Inspecting the sampler parts. During assembly of the integrated sampler, each part should be carefully checked for physical damage that could permit air leaks (cracks, worn or warped O-rings, thread damage, etc.). Defective parts should be replaced.

3. Inspecting the filters. As part of the sampler assembly process, each filter is carefully inspected for physical defects (e.g., pinholes, tears, abnormal color, thin or thick areas). This is usually

done by viewing the filter against a light table. After inspection, the filter is loaded into the integrated sampler.

4. Assembling the integrated sampler. The integrated sampler is assembled in sections (stages). Activity numbers 2 and 3 above are repeated for each section. When all sections of the sampler have been assembled and attached together, the sampler is stored in a sealed contaminant free container. For example, Figure 8-1 shows the American filter pack used in EPA's National Dry Deposition Network (NDDSN). This filter pack is composed of three sections or stages:

   a. Teflon filter section - for the collection of particulate sulfate and nitrate.

   b. Nylon filter section - for the collection of nitric acid.

   c. Whatman 41 filter section - two K_2CO_3 treated filters for the collection of sulfur dioxide.

   Activity numbers 2 and 3 above are repeated as each section of the filter pack is assembled. When asembled, the filter pack is capped on both ends, labeled with a sample I.D., and stored in a resealable plastic bag.

5. Assigning sampler I.D. number. Each asembled integrated sampler is assigned a sample identification number. To avoid sample mix-up, the sample I.D. number should be put directly on the integrated sampler.

6. Keeping records. Record-keeping or documentation is a very important part of the sampler assembly process. It is not only important to know the sampler I.D. number, but the history of each part of the integrated sampler. The following information should be recorded for each assembled sampler:

   -- Sampler I.D. number
   -- Date assembled
   -- Name of assembler
   -- Lot number for each liner, filter or denuder tube used in the integrated sampler (e.g., for an NDDN filter pack, information would include teflon filter lot number, nylon filter lot number, and treated Whatman filters lot number.)

8.2.2 Packaging of equipment and supplies. The equipment and supplies needed to keep a monitoring project operating are prepared for shipment to the monitoring site by the central laboratory. Some equipment (e.g., integrated samplers) are sent to the monitoring sites on a routine schedule. Other supplies (e.g., printer ribbons, weekly status report forms, computer paper, etc.) are sent to the monitoring sites as needed. It is important to have good lines of communication between the site operators and the central laboratory to ensure timely shipment of equipment and supplies.

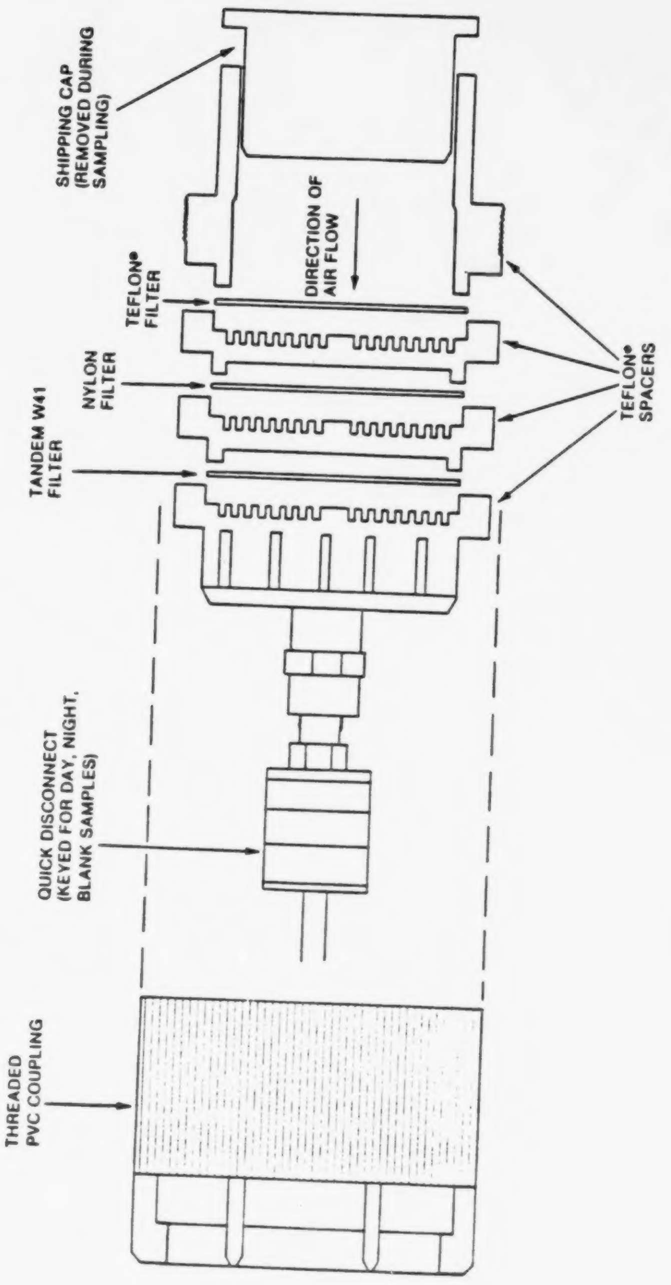

SHIPPING CAP (REMOVED DURING SAMPLING)
DIRECTION OF AIR FLOW
TEFLON® FILTER
NYLON FILTER
TANDEM W41 FILTER
TEFLON® SPACERS
QUICK DISCONNECT (KEYED FOR DAY, NIGHT, BLANK SAMPLES)
THREADED PVC COUPLING

Figure 8-1. American filter pack assembly.

General activities included in the packaging and shipping of equipment and supplies fall into three categories.

1. Packaging and shipping integrated samplers. Depending on the individual monitoring project's operating procedures, this can be as simple as: (a) sealing the sampler and appropriate forms (e.g., return mailing labels, chain of custody form) in a mailing container, (b) attaching the mailing label, and (c) mailing.

NOTE: At this point in the shipment of samplers to the monitoring site, the following information must be documented for each integrated sampler:

a. Monitoring site receiving sampler
b. Sampler I.D. number
c. Date shipped
d. Date assembled
e. Name of assembler
f. Lot number for each sampler component (filter, liner, or denuder tube)

2. Packaging and shipping of wet deposition sampling media. For monitoring sites collecting wet deposition samples, the following supplies need to be shipped to the monitoring sites at regular intervals. The frequency shown in brackets next to each item are shipping frequencies used for NDDN sites collecting wet deposition samples.

a. Clean buckets or bucket liners [monthly]

b. Sample bottles [monthly]. Sample bottles should be labeled in accordance with the project's SOP for wet deposition sampling. Depending on the project, some bottles are pre-labeled with site I.D., sampling period, etc., while others have blank labels to be filled in by the site operator when the sample is collected.

c. Low ionic strength samples [bimonthly]

d. Conductivity standards [quarterly]

e. pH buffer solutions [semiannually]

f. Wet deposition data forms [as needed]

3. Packaging and shipment of other supplies. The laboratory serves as a central distributor for equipment, supplies, and replacement parts. This includes replenishing and replacing supplies. Examples are given below.

-- Replenishment of site-maintained inventories

  -- Site data forms
  -- Logbooks
  -- Computer disks
  -- Printer ribbons

  - Chart paper
  - Computer paper
  - Mailing labels
  - Sample labels
  - Instrument filters
  - Tools

- Replacement parts for site equipment

  - Continuous monitors
  - Data acquisition systems
  - Meteorological systems
  - Wet-dry collectors
  - Rain gauges
  - pH meters
  - Conductivity meters
  - Balances

8.2.3 Quality control. Quality control activities associated with the preparation and shipment of sampling equipment and supplies include:

1. Following acceptable laboratory practices to ensure sampler integrity.

   - Wearing powder free plastic gloves when handling filters.
   - Performing sample media preparation and integrator sample assembly in a contamination-free environment.
   - Avoiding contamination of sampling media in all stages of sampler preparation (e.g., being extra cautious performing the physical inspection of sampling media during sampler assembly).

2. Use of color coded samplers, labels, etc., wherever possible.

3. Inspection of sampling media for physical defects (pinholes, tears, etc.).

4. Inspection of integrated sampler parts for physical defects (cracks, worn or warped O-rings, thread damage, etc.).

5. Analysis of a representative sample from each batch of treated filters to ensure compliance with acceptance criteria.

6. Setting aside 1 or 2 assembled integrated samplers from each batch for storage and analysis as a laboratory integrated sampler blank. This is done to ensure the sampling media are not being contaminated during sampler assembly or by the sampler during storage.

7. Inclusion of adequate record-keeping procedures to ensure the traceability of sampling equipment and supplies.

-- Integrated samplers. Each filter, liner, or denuder tube should be traceable by lot number to the acceptance data for untreated material, acceptance data on treated material, etc.

8. Following the SOP for the preparation and shipment of sampling equipment and supplies.

8.3 Receipt and Log-in of Samples

The frequency of sample receipt is dependent on the project's sampling schedule (daily, weekly, event). Received samples should be processed immediately to ensure their timely analysis. General activities included in sample receipt and log-in are:

1. Inspection of shipping container. Visually inspect the shipping container for physical damage. Any damage should be recorded in the sample receipt logbook.

2. Inspection of container contents. Inspect container contents for:

   -- Physical damage to the samples.

   -- Inclusion of samples and appropriate forms (checksheets, data forms, etc.).

   -- Discrepancies - compare the site name and sample I.D. number of received samples with those recorded in the shipping log. Any discrepancies should be recorded.

   -- Completeness and supply requests - check all enclosed forms for completeness. Any requests for supplies should be sent to appropriate personnel. Missing forms, information, etc., should be noted in the logbook and reported to project personnel for immediate follow-up.

3. Log-in of samples. Sample receipt is documented in the logbook and includes:

   -- Name of site
   -- Date samples received
   -- Sample I.D. numbers
   -- Sample type
   -- Any discrepancies found during inspection (steps 1 and 2 above)

4. Submit samples for processing. Received samples and completed laboratory sample form (I.D. form that stays with sample throughout analysis process) are submitted to laboratory personnel for processing.

8.3.1 Quality control. Quality control activities for receipt and log-in of samples include:

1. Comparison of shipping logbook with sample receipt information (sample I.D. number, site name) to ensure sample integrity.

2. Inspection of samples for:

   -- Physical damage
   -- Enclosure and completeness of required data forms

3. Adherence to the SOP for sample receipt and log-in.

8.4 Preparation and Storage of Samples for Analysis

Procedures for the preparation and storage of samples for analysis depend on sample type, pollutants being measured, and project storage requirements. Dry deposition samples require more sample preparation than wet deposition samples.

Sample storage procedures are project specific. Some monitoring projects store all samples at 4°C including:

-- Dry deposition samples still in the integrated sampler (refrigerated as received from field)

-- Integrated sample extracts

-- Wet deposition samples

8.4.1 Preparation of dry deposition samples for analysis. Specific procedures for the preparation of dry deposition samples for analysis are sampler and pollutant dependent. General activities for sample preparation include:

-- Unloading the integrated sampler
-- Extraction of sampling media

8.4.1.1 Unloading the integrated sampler. SOP's followed for unloading integrated samplers are type and pollutant dependent. General activities associated with unloading a sampler include:

1. Label a sample bottle for each type of filter, liner, or denuder tube being extracted. This label will include:

   -- Site
   -- Sample I.D. number
   -- Sampler type (TFR, annular denuder, filter pack)
   -- Sample type (teflon filter, nylon liner)

   Use of color coded labels allows easy recognition of sample type (e.g., red labels for teflon filters).

2. Inspect sampler for damage. Record any damage in logbook.

3. Wearing gloves, disassemble the sampler one section at a time. Activities during disassembly include:

    a. Removal of sampling media or denuder tube from each section. (Clean tweezers are used to remove filters.)

    b. Inspection of filter, liner, or denuder tube for damage (e.g., holes, tears, signs of leakage). Observations are recorded in logbook.

    c. Placement of filter or liner into properly labeled bottle. (Denuder tubes will be extracted into labeled bottles.)

    d. Cap bottle securely.

    e. Samples are ready for extraction.

8.4.1.2 Extraction of sampling media. Procedures used to extract dry deposition samples are sampler type and pollutant dependent. General activities associated with extraction of sampling media include:

1. Addition of a known volume of extracting solution to the sample bottle. (For denuder tubes, the tube is washed with a known volume of extracting solution.)

2. Timed extraction of samples using sonication, shaking table, or combination of both procedures.

3. Storage of extracted sample in refrigerator at 4°C. Samples should sit overnight before being analyzed and are usually analyzed within 48 hours after overnight equilibration.

Table 8-3, taken from the January 1988 draft QAPP for EPA's ACID MODES Field Study, lists the extraction procedures for TFR and filter pack samples.

Table 8-3. TFR/Filter Sample Extraction[a]

Samples	Extraction solution	Volume	Sonication time
Nafion liner	0.1 N NaOH	5 ml	2 hrs.
Nylon liner	3.0 mM $NaHCO_3$/ 2.4 mM Na_2CO_3	5 ml	30 min.
Teflon filter	Water	10 ml	30 min.
Nylon filter	3.0 mM $NaHCO_3$/ 2.4 mM Na_2CO_3	10 ml	30 min.
Citric acid-impregnated filter	0.1 M sodium citrate	10 ml	30 min.[b]
K_2CO_3-impregnated filter	0.06% H_2O_2 in 0.2 N HCl	10 ml	30 min.
Triethanolamine-impregnated filter	Water	10 ml	30 min.

[a] All extractions are performed by using sonication.

[b] Extracts will sit for at least 24 hours under refrigeration to allow citric acid to dissolve completely.

Figure 8-2 shows the flow chart for extraction of dry deposition filters from NDDN's American filter pack.

8.4.2 Quality control. Quality control (QC) activities associated with the preparation and storage of samples for analysis include:

1. Following standard laboratory practices to ensure sample integrity.
    - -- Wearing powder-free plastic gloves when handling sampling media.
    - -- Performing sample disassembly and sample preparation in a contaminant free environment.
2. Use of color coded labels, bottles, etc., wherever possible.
3. Inspection of samples for damage (e.g., tears, signs of leakage, breakage).
4. Inclusion of adequate record-keeping procedures to ensure sample traceability (e.g., site, sample I.D. number, sampling dates [start, stop], etc.).

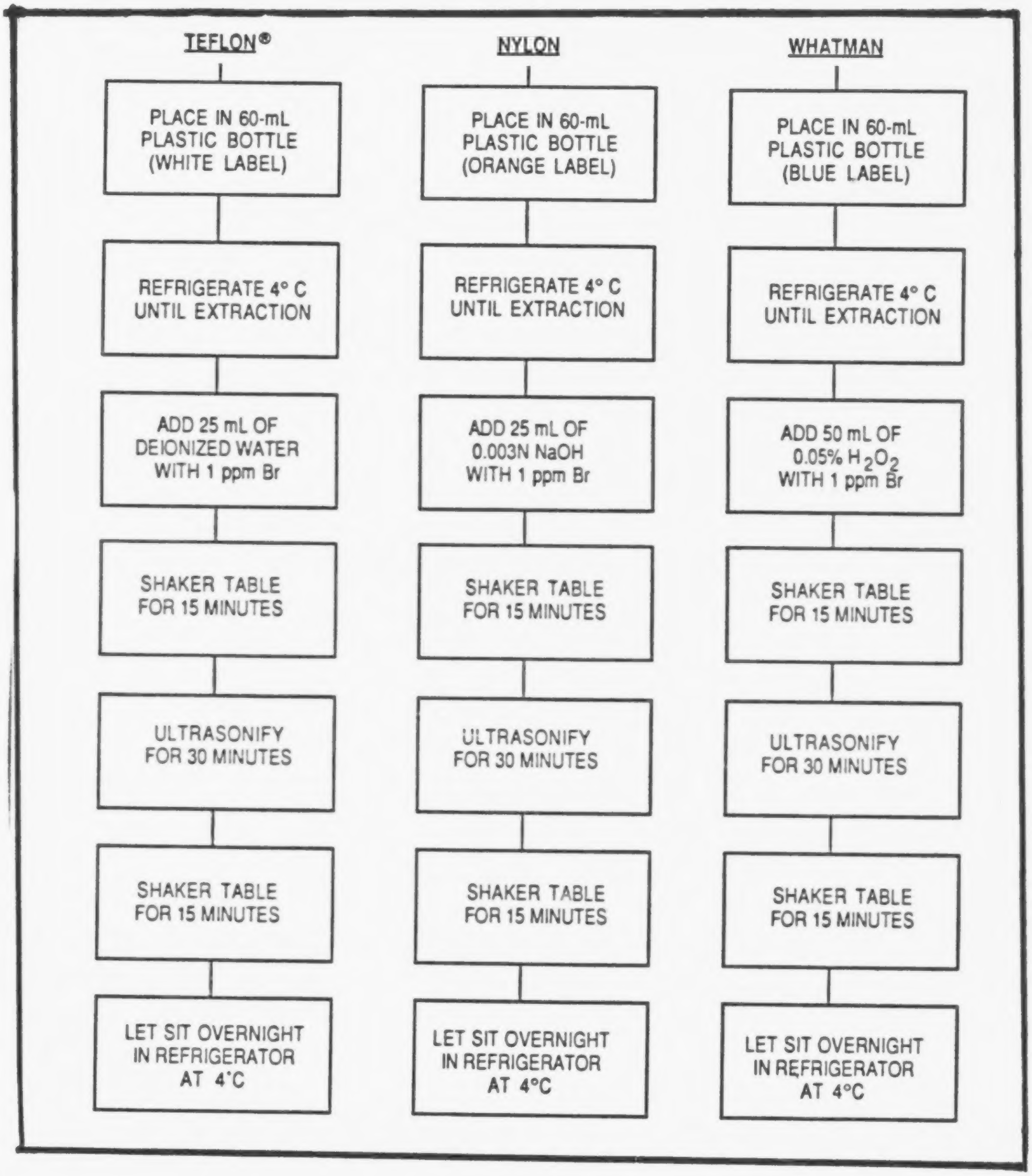

TEFLON®
NYLON
WHATMAN
PLACE IN 60-mL PLASTIC BOTTLE (WHITE LABEL)
PLACE IN 60-mL PLASTIC BOTTLE (ORANGE LABEL)
PLACE IN 60-mL PLASTIC BOTTLE (BLUE LABEL)
REFRIGERATE 4° C UNTIL EXTRACTION
REFRIGERATE 4° C UNTIL EXTRACTION
REFRIGERATE 4° C UNTIL EXTRACTION
ADD 25 mL OF DEIONIZED WATER WITH 1 ppm Br
ADD 25 mL OF 0.003N NaOH WITH 1 ppm Br
ADD 50 mL OF 0.05% H_2O_2 WITH 1 ppm Br
SHAKER TABLE FOR 15 MINUTES
SHAKER TABLE FOR 15 MINUTES
SHAKER TABLE FOR 15 MINUTES
ULTRASONIFY FOR 30 MINUTES
ULTRASONIFY FOR 30 MINUTES
ULTRASONIFY FOR 30 MINUTES
SHAKER TABLE FOR 15 MINUTES
SHAKER TABLE FOR 15 MINUTES
SHAKER TABLE FOR 15 MINUTES
LET SIT OVERNIGHT IN REFRIGERATOR AT 4°C
LET SIT OVERNIGHT IN REFRIGERATOR AT 4°C
LET SIT OVERNIGHT IN REFRIGERATOR AT 4°C

Figure 8-2. Flow chart for extraction of dry deposition filters.

5. Adherence to SOP's for preparation and storage of samples for analysis.

8.5 Analysis of Samples

Analytical procedures used in the analysis of dry deposition monitoring samples are project and pollutant specific. Each monitoring project must develop a set of analytical procedures that:

1. Covers the specific pollutants being collected.

2. Provides for timely analyses and assessment of samples.

3. Yields data of known and acceptable quality that meets the project's needs.

8.5.1 Analytical techniques. Analytical techniques commonly used for sample analysis are:

-- Ion chromatography
-- Automated colorimetry
-- Atomic absorption (flame)
-- Atomic emission (ICP and flame)

Analytical techniques employed in EPA's National Dry Deposition Network (summarized in Table 8-4) are typical of those used for acid deposition monitoring.

8.5.2 Development of SOP's. Standard operating procedures (SOP's) must be written for each of the analytical techniques used in sample analysis. When consistently followed by laboratory personnel, SOP's ensure analytical data are comparable and of known and acceptable quality.

By definition, an SOP is a written procedure that gives step-by-step instruction on how to perform a task or analysis. SOP's should be written in clear, easy to understand language. They should be written so a person, with limited experience following the procedure, can successfully perform the task. SOP's should include:

-- Scope or background information
-- Equipment and supplies needed to perform the task
-- Procedures for preparation of reagents
-- Procedures for preparation of calibration standards
-- Procedures for instrument setup
-- Procedures for instrument calibration
-- Procedures for sample analysis
-- Quality control
-- Data reduction
-- Calculations
-- Reporting of results
-- Instrument maintenance

Table 8-4. Summary of NDDN Laboratory Analyses

Parameter	Analytical technique	Matrix	Minimum detection limit (μg/L)*	Reference⁺
Calcium (Ca^{+2})	Inductively coupled plasma--atomic emission	Water	10	a
Magnesium (Mg^{+2})	Inductively coupled plasma--atomic emission	Water	10	b
Sodium (Na^{+})	Inductively coupled plasma--atomic emission	Water	10	c
Potassium (K^{+})	Flame atomic emission	Water	10	d
Ammonium (NH_4^{+}-N)	Automated colorimetry	Water	10	e
Chloride (Cl^{-})	Ion chromatography	Water	30	f
Nitrite (NO_2^{-}-N)	Ion chromatography	Water	8	f
Nitrate (NO_3^{-}-N)	Ion chromatography	Water, filter extract	8	f
Orthophosphate (PO_4^{-3}-P)	Ion chromatography	Water	5	f
Sulfate (SO_4^{-2})	Ion chromatography	Water, filter extract	40	f
Acidity (as H^{+})	Auto titration	Water	5	g

Note: μg/L = micrograms per liter

*For precipitation samples or filter pack extracts

⁺References:
a = NDDN Laboratory Operations Manual Section 9.0
b = NDDN Laboratory Operations Manual Section 9.0
c = NDDN Laboratory Operations Manual Section 9.0
d = NDDN Laboratory Operations Manual Section 9.0
e = NDDN Laboratory Operations Manual Section 8.0
f = NDDN Laboratory Operations Manual Sections 4.0 and 7.0
g = NDDN Laboratory Operations Manual Section 10.0

Source: ESE, 1988

Two examples of SOP's used in EPA's National Dry Deposition Network, "Analysis of Dry Deposition Filter Extracts by Ion Chromatography" and "EPA Method 350.7 for the Measurement of Ammonium in Wet Deposition Samples by Autoanalyzer®," are located in Appendices N and O, respectively. These SOP's are typical of those used in acid deposition monitoring. Using the outline of what an SOP should include (listed on page 75) and the sample SOP's in Appendices N and O as guidelines, project specific SOP's can be developed.

8.5.3 Chemical measurements. Dry deposition samples collected with integrated samplers (TFR, annular denuder, filter pack) are typically analyzed for particulates (SO_4^{-2}, NO_3^-), HNO_3, and SO_2. Precipitation samples from monitoring sites collecting wet deposition are typically analyzed for: pH, specific conductance, acidity, NH_4^+, PO_4^{-3}, SO_4^{-2}, NO_3^-, Cl^-, Na^+, K^+, Ca^{+2}, and Mg^{+2}.

8.5.4 Quality control. Many quality control activities for sample analysis are instrument specific. An example of this type of activity would be the control of instrument sensitivity or separation by column or lamp replacement at specified intervals.

General QC activities associated with sample analysis include:

1. Analysis of filter blanks.
2. Analysis of reagent blanks.
3. Analysis of a reference sample (if possible, NBS-traceable) to assess and monitor accuracy.
4. Periodic analysis of control samples (e.g., every 10 samples) to monitor instrument drift and determine analytical precision.
5. Following standard laboratory practices to ensure sample integrity.

   -- Routine checking and maintenance of D.I. water quality.
   -- Routine calibration and maintenance of analytical balances.
   -- Analysis conducted in a contaminant-free environment.

6. Adherence to SOP's for sample analysis.
7. Maintaining control charts (control samples, filter blanks, etc.).

8.6 Validation and Transfer of Data to the Data Base

The data validation process for field samples begins in the analytical laboratory and is completed by data management after the data is transferred to the data base. General activities associated with the laboratory validation of data are:

1. Review of quality control performed during analysis.

   a. Does the calibration curve meet the acceptance criteria for correlation coefficient and intercept?

   b. Does the reference sample (NBS-traceable when possible) analyzed at the beginning and end of the analysis meet the acceptance criteria (e.g., ± 5%)?

   c. Do the QC standards analyzed at specific intervals (e.g., every 10 samples) meet the acceptance criteria (e.g., ± 5%)?

   d. Is the data reasonable?

2. Review of number transcriptions, calculations, etc., to ensure they are correct.

3. Any samples in an analytical set not passing the QC checks discussed in Number 1 above must either be reanalyzed or the sample data flagged.

4. Assignment of appropriate flags to data from samples that were:

   a. Damaged during sampling or sample preparation (e.g., torn filter).

   b. Analyzed in a data set not meeting the acceptance criteria (see Number 1 above).

   c. Found to be deficient (e.g., proper site forms or checksheets not returned with sample).

Upon completion of this initial phase of data validation, the data is transferred to the data base. In the data base, the analytical data will be combined with the field data and subjected to additional validation procedures. Data transfer procedures are project specific. They can be as simple as copying the data to a floppy disk for transfer to the data base, or as involved as entering the data into the data base manually. No matter what process is followed, care should be taken to ensure the data going into the data base is identical to that produced during sample analysis.

8.6.1 Quality control. Data validation is itself a quality control (QC) procedure. QC activities associated with the data validation include:

1. Adherence to the data validation SOP.

2. Review of the data to ensure calculations and data transcriptions are accurate.

3. Review of the data transfer process to ensure the analytical data in the data base is identical to that produced during sample analysis.

4. Review of all flags to ensure they are appropriate and properly transferred to the data base.

8.7 QA's Role in Laboratory Operations

Quality assurance activities during the initial phases of the monitoring project include ensuring that:

-- SOP's for all laboratory operations (sample preparation, sample analysis, data validation, etc.) are accurate and meet the project's needs.

-- Adequate QC procedures are included in all phases of the laboratory operations to ensure project quality objectives are being met.

-- Analytical methods used in sample analysis will produce data meeting the project's quality objectives and needs.

-- Documentation procedures for all laboratory operations are well defined and meet the project's needs.

-- Acceptance and validation criteria are well defined for all laboratory operations (e.g., acceptance testing of treated filters).

Once the monitoring project is operating in a routine manner, quality audits of laboratory operations are conducted on a regular schedule (e.g., every 6 months) to assure generated data:

-- Is of defined quality, and
-- Meets the needs of the project.

Both systems and performance audits are conducted.

8.7.1 Systems audits. Systems audits of laboratory operations are conducted at project initiation and then on a regular schedule (e.g., annually) for the life of the project. The systems audit is used to verify that:

1. The laboratory is operating in a timely, efficient, well documented manner consistent with the project's objectives.

2. The quality control (QC) procedures specified for each measurement process or system are performed in a timely manner and in conformance to the criteria specified in the SOP's (i.e., you're doing what you say you're doing).

3. The QC procedures specified for laboratory operations are adequate to assure that generated data meets the project's quality objectives and needs (i.e., what you're doing is effective and validates the data quality).

4. The laboratory is responding to and meeting the project's needs in a timely manner (i.e., calibrations of instruments are done correctly and on time; supplies are sent on time; sampling equipment [e.g., integrated sampler] is received on schedule; sample analysis is timely, etc.).

Listed below are activities generally audited during a laboratory operations systems audit and some sample questions that would be asked about each activity.

1. Organization and responsibilities. How is the laboratory organized and who is responsible for each laboratory function (sample receipt, sample preparation, sample analysis, etc.)?

2. Document control/documentation. Are all activities associated with laboratory operations well documented (SOP's, manuals, etc.)? Are these documents kept up to date? How is this done? Are record-keeping activities being performed? Are they done in a manner consistent with the SOP for the activity? Can personnel retrieve needed information, data, etc., in a timely, efficient manner?

3. Training. How are laboratory operations personnel trained? How often is training given? What measures are taken to ensure the training is adequate? Who does the training?

4. Lot control. What mechanisms are employed to track and control the various lots of chemicals, sampling media (filters), etc., used in the laboratory? Are these mechanisms adequate for project needs? How are sample integrity and traceability assured?

5. Sample custody. What sample custody procedures are used by the laboratory? Does the sample have to meet rigid sample custody regulations (usually used for samples that may be used for legal actions)? What procedures are used to track the sample from the time the sampler is prepared for shipment to the field, through actual sampling, receipt from field, preparation for analysis, analysis, data reduction, and placement of sample data into the data base?

6. Procurement and testing. What procurement procedures are used by the laboratory? Are they well documented? What acceptance testing is performed? Is it documented? How? What criteria are used to determine acceptability of material for project use? Are these criteria adequate to meet the project's needs?

7. Calibration procedures. What is calibrated? How often? What procedures are followed for the calibration? Is an SOP available? Is it accurate? Is it being followed? Are the standards used for calibration traceable to a primary standard such as an NBS standard?

8. Analytical procedures. What is being analyzed for? How is it analyzed? How is the instrument used in the analysis calibrated? Is there an SOP for the analytical procedure? Is it accurate? Is it being followed? How is data quality assessed? How is it assured?

9. Data reduction, validation and reporting. How is the data reduced? Is there a written procedure (SOP) for this? What criteria are used to validate the data? Is there an SOP for validation? Is it accurate? Is it adequate? Is it being followed? How are the laboratory

data reported? Where are final data reports sent? How does data get from the laboratory to the project's data base? Is there an SOP for this process?

10. Maintenance (preventive and corrective). What type of maintenance is performed on the laboratory instruments, balances, D.I. water supply, etc.? Is there a written procedure for the maintenance? Where are maintenance records kept? Are they accurate and adequate? Do they list maintenance performed, date performed, personnel performing the maintenance, etc.?

11. Corrective action. How are problems identified? How are problems reported? Who is responsible to see corrective action is taken? Is there a form for reporting problems? How are responses to corrective action requests tracked?

12. Traceability. What mechanisms are used to ensure the traceability of all data residing in the data base back through all the steps, procedures, and processes performed to its very beginning? For example, particulate sulfate data would be traced back through the validation, data reduction, analysis, sampling, and filter acceptance stages to the procurement of the filter used to collect it. Are laboratory documentation procedures adequate for timely, accurate traceability of the analytical data? Does the laboratory routinely perform traceability audits on the data?

    Note: A traceability audit is often done as part of a systems audit of a project's data management system.

13. Reports to management. What type of reports are sent to management? How often? What do they include?

As illustrated by the preceding discussion, the systems audit of laboratory operations is an intense review of all project activities conducted by the laboratory. Because of the audit's complexity, an audit questionnaire or checksheet is usually used to guide the auditor through each area of interest. For the systems audit to be effective, each monitoring project must develop audit procedures and questionnaires that specifically address their project's activities. The preceding discussion of activities generally included in a laboratory operations systems audit, the NDDN laboratory system audit questionnaire in appendix H, and laboratory portions of the systems audit questionnaire used in the Mountain Cloud Chemistry Project (MCCP) in Appendix I serve as guides in the development of project-specific systems audits.

8.7.2 Performance audits. Performance audits of laboratory operations are conducted on a routine schedule. These audits verify that the data being generated by the laboratory meets the project's data quality requirements and needs. Analytical performance is usually evaluated through analysis of QA samples by the laboratory. Usually, QA samples are synthetically produced samples (e.g., spiked filters, solutions) containing known concentrations of the pollutants of interest. These samples are submitted to the laboratory as blind QA samples and are analyzed using the same procedures used for the field samples. Analytical results for the QA samples are reported to the auditor. The auditor compares the analyzed values with the expected values (the known concentrations) to verify the analytical procedure is being operated within the project's performance criteria. Any exceedances are reported to the laboratory and appropriate corrective action is taken. Corrective action generally involves:

- -- Review of analysis data for miscalculations, errors, etc.
- -- Reanalysis of samples.
- -- Review of analytical procedures.
- -- Flagging of sample data associated with QA samples exceeding acceptable limits.

Performance audits of laboratory operations are usually performed at least twice a year. Many projects have quarterly audits, some continual audits. Those conducting continual audits, usually have the laboratory periodically analyze QA samples (e.g., one QA sample for every 20 samples).

8.7.3 Quality audit results. Quality audits are conducted to verify that laboratory operations are functioning in a manner consistent with the quality objectives and needs of the project. Any deviations from standard procedures, exceedances of analytical limits (criteria), etc., are to be brought to the attention of project management for immediate investigation and correction. Auditors usually give a verbal report of findings to the audited laboratory at the conclusion of the audit. A written report should follow within a reasonable time frame (about 2 weeks).

8.8 Summary

As the focal point of all project activities, the central laboratory houses both laboratory operations and data management activities. Laboratory operations is essential to the operation of the monitoring project. Activities associated with laboratory operations are:

- -- Acquisition and testing of materials.
- -- Preparation and shipment of sampling equipment and supplies to the sites.
- -- Receipt and preparation of samples for analysis.
- -- Analysis of samples.
- -- Validation and reporting of data.

Data quality is affected by how well each of the above activities is perfomed and documented. Quality audits (both systems and performance) are conducted on a regular schedule to verify:

1. Laboratory operations are being conducted in accordance with the project's written requirements (e.g., QAPP).

2. The quality objectives and needs of the project are being met.

9.0 DATA MANAGEMENT

Data management controls the flow of information between all components of the monitoring project. Activities generally associated with this include:

1. Acquiring field and analytical data.
2. Tracking data from collection to storage in the data base with documentation.
3. Providing traceability of data to all activities involved in its collection, analysis, validation and storage (e.g., filter lot number, instrument calibration).
4. Reviewing and validating collected data.
5. Coding data with meaningful flags.
6. Producing statistical summaries and reports.
7. Generating control charts and other graphical presentations of data.
8. Documenting data base and project operation changes (e.g., changes in sampling methods, measured parameters).

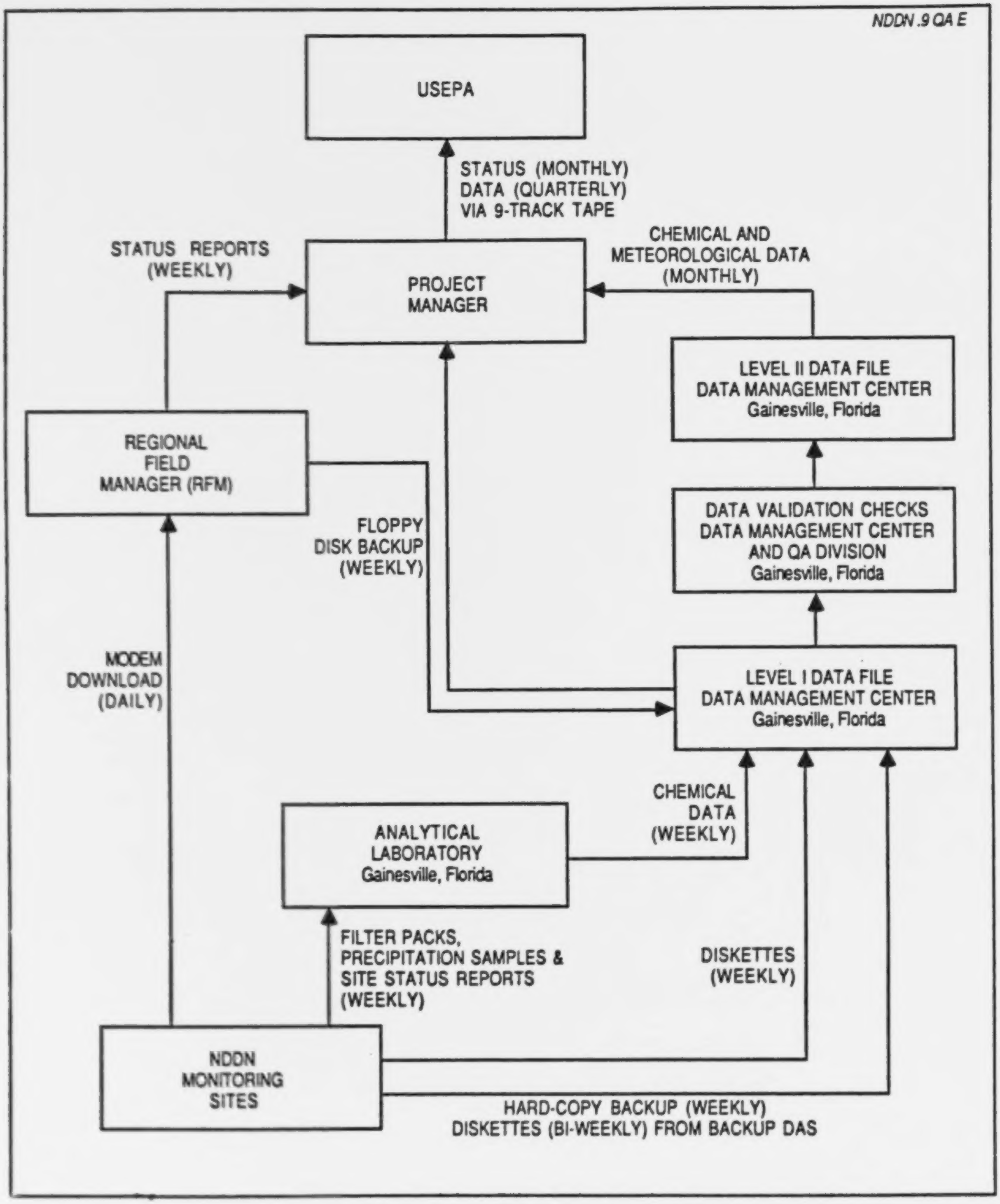
To accomplish these activities in a timely and efficient manner, the project must have an effective data flow system. This includes systems for:

-- Collection and transfer of monitoring site data
-- Analysis and transfer of field sample data
-- Compilation, validation, and storage of data in the data base

Data flow systems employed in EPA's NDDN are typical of most dry deposition monitoring projects. Figure 9-1 is a diagram of data flow within NDDN. Figures 9-2 and 9-3 show more detailed diagrams of data flow within the monitoring sites and analytical laboratory. When accompanied by adequate documentation, these systems provide the basis for tracking data throughout the entire measurement process.

9.1 Data Acquisition

Many dry deposition monitoring projects use the concentration monitoring approach to estimate deposition velocities. This approach requires the use of chemical concentration data, meteorological measurements, and biological parameters to estimate deposition velocities. To meet these requirements, data management systems typically collect and store the following:



NDDN.9 QA E
USEPA
STATUS (MONTHLY)
DATA (QUARTERLY)
VIA 9-TRACK TAPE
STATUS REPORTS (WEEKLY)
PROJECT MANAGER
CHEMICAL AND METEOROLOGICAL DATA (MONTHLY)
LEVEL II DATA FILE DATA MANAGEMENT CENTER Gainesville, Florida
REGIONAL FIELD MANAGER (RFM)
DATA VALIDATION CHECKS DATA MANAGEMENT CENTER AND QA DIVISION Gainesville, Florida
FLOPPY DISK BACKUP (WEEKLY)
MODEM DOWNLOAD (DAILY)
LEVEL I DATA FILE DATA MANAGEMENT CENTER Gainesville, Florida
CHEMICAL DATA (WEEKLY)
ANALYTICAL LABORATORY Gainesville, Florida
FILTER PACKS, PRECIPITATION SAMPLES & SITE STATUS REPORTS (WEEKLY)
DISKETTES (WEEKLY)
NDDN MONITORING SITES
HARD-COPY BACKUP (WEEKLY)
DISKETTES (BI-WEEKLY) FROM BACKUP DAS

Figure 9-1. Flow chart of NDDN data.

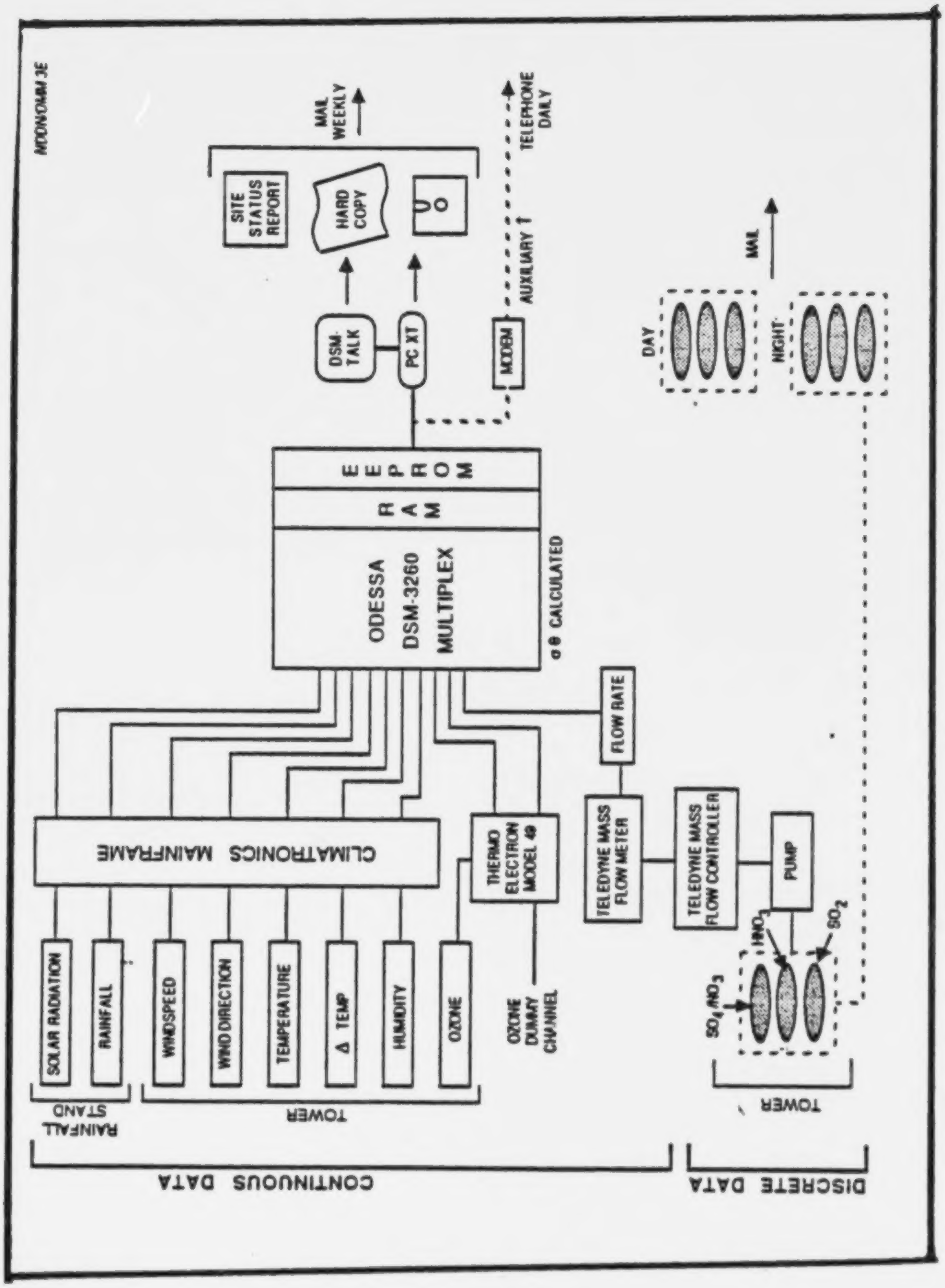

NDDN/OMM/JE
SITE STATUS REPORT
HARD COPY
U O
MAIL WEEKLY
TELEPHONE DAILY
AUXILIARY
DSM-TALK
PC XT
MODEM
EEPROM
RAM
ODESSA DSM-3260 MULTIPLEX
σθ CALCULATED
DAY
NIGHT
MAIL
FLOW RATE
CLIMATRONICS MAINFRAME
THERMO ELECTRON MODEL 49
TELEDYNE MASS FLOW METER
TELEDYNE MASS FLOW CONTROLLER
PUMP
SOLAR RADIATION
RAINFALL
WINDSPEED
WIND DIRECTION
TEMPERATURE
Δ TEMP
HUMIDITY
OZONE
OZONE DUMMY CHANNEL
SO_4 NO_3
HNO_3
SO_2
RAINFALL STAND
TOWER
TOWER
CONTINUOUS DATA
DISCRETE DATA

Figure 9-2. Detailed flow diagram of NDDN field operations.

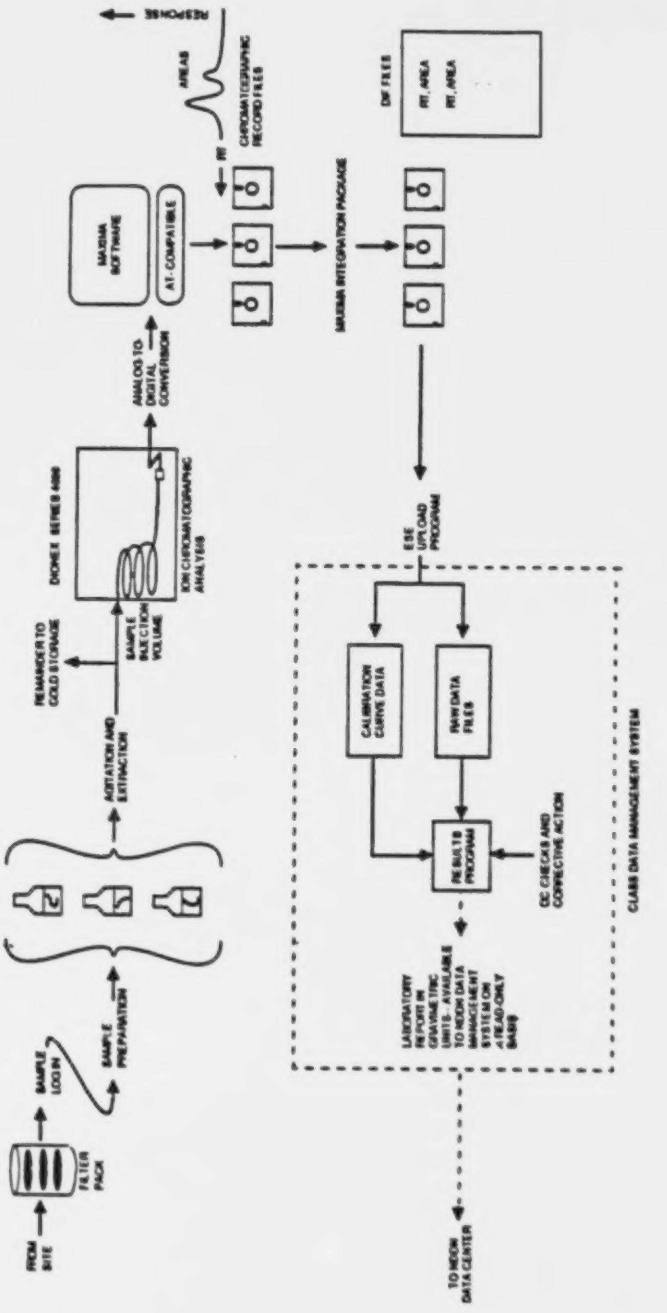

FROM SITE
FILTER PACK
SAMPLE LOG IN
SAMPLE PREPARATION
AGITATION AND EXTRACTION
REMAINDER TO COLD STORAGE
SAMPLE INJECTION VOLUME
DIONEX SERIES 4000
ION CHROMATOGRAPHIC ANALYSIS
ANALOG TO DIGITAL CONVERSION
MAXIMA SOFTWARE
AT-COMPATIBLE
RT
AREAS
RESPONSE
CHROMATOGRAPHIC RECORD FILES
MAXIMA INTEGRATION PACKAGE
DIF FILES
RT, AREA
RT, AREA
ESE UPLOAD PROGRAM
CALIBRATION CURVE DATA
RAW DATA FILES
RESULTS PROGRAM
QC CHECKS AND CORRECTIVE ACTION
LABORATORY REPORT IN GRAVIMETRIC UNITS - AVAILABLE TO NDDN DATA MANAGEMENT SYSTEM ON A READ-ONLY BASIS
CLASS DATA MANAGEMENT SYSTEM
TO NDDN DATA CENTER

Figure 9-3. Flow diagram of NDDN data.

Reproduced from best available copy.

1. Continuous monitoring data from the field. This includes:

   - Meteorological data
     - Wind speed
     - Wind direction
     - Sigma theta
     - Temperature
     - Delta temperature
     - Relative humidity or dew point
     - Solar radiation
     - Precipitation amount
     - Surface wetness

   - Continuous monitor data
     - Ozone (O_3)
     - Sulfur dioxide (SO_2)

   - Flow data (e.g., flow rate of integrated sampler)

2. Analytical results of field samples

   - Integrated samples
     - Nitric acid
     - Particulate sulfate and nitrate
     - Sulfur dioxide
     - Ammonia

   - Wet deposition samples
     - Wet/dry samples
     - Rainfall

3. Biological and meteorological observations (These are routinely recorded by the site operator on the site status form.)

   - Foliage information
     - Percent of leaves on trees
     - Leaf color
     - Leaf drop

   - Snow
   - Dew
   - Frost
   - Fog

4. Detailed site descriptions for each monitoring site (See Section 3.0 on site selection.)

The above collected data along with adequate documentation comprises the data base from which the validated data base is produced. Documentation typically includes:

1. Calibration history for all field equipment including:

   -- Site name

   -- Calibration dates

   -- Equipment calibrated

   -- Calibration curves, factors, etc.

   -- Dates this calibration data was used to calculate field data results

2. Equipment I.D. number, sample lot numbers, etc. that allow the stored data to be traced back to:

   -- Acceptance test data (e.g., treated sample media, untreated sample media, etc.)

   -- Equipment calibration data

   -- Analytical analysis data including:
      -- Instrument calibration curve (e.g., ion chromatography atomic emission)

      -- QC samples analyzed with field samples

      -- Analytical results for the primary standard (NBS traceable when possible

3. Audit results

   -- Performance
   -- Systems

9.2 Data Validation

Monitoring data usually undergo a two or three level validation process. Data reach the validation process through one of two pathways.

1. Field samples are sent from the monitoring site to the laboratory for analysis. The analytical data and supporting documentation are transferred to the data management center for further validation and storage.

2. Field data (continuous ozone, meteorological data, etc.) are sent directly to the central laboratory's data management center for validation and storage.

9.2.1 Level I validation. During the initial validation process (Level I), data is evaluated on the basis of site operational records and QC test results.

9.2.1.1 Analytical data. Analytical data sent to the data management center by the laboratory is level I validated data. This data includes documentation, data flags, and comments. Section 8.6 outlines laboratory validation procedures.

9.2.1.2 Field data. Level I validation of field data is often a two step operation:

1. Data validation performed by the site's data acquisition system.

2. Data validation performed by the central laboratory's data management center.

9.2.1.2.1 Site validation of data -- Many monitoring projects use field data acquisition systems (DAS) that begin data validation during the data collection process. The DAS usually collects continuous data in the form of 5-minute averages and hourly averages. When each 5-minute average is formed, information regarding the validity of that average is checked. Any of the conditions listed below will result in the attachment of a data flag to the average.

1. A power failure during the time interval
2. Bad-status indication
3. Calibration in process
4. Channel downed by operator
5. Sensor indicates a value outside predetermined high or low limits

Averages falling outside predetermined high or low limits (Number 5 above) have an alarm flag attached to them. This flag is used to alert project personnel that the flagged data needs to be carefully reviewed during the validation process. It does not invalidate the data.

Hourly averages are formed from 5-minute averages. (Flagged 5-minute averages are not used to form the hourly average.) To be considered valid, the hourly average must be constructed from a predetermined number of valid (non-flagged) 5-minute averages. Usually nine valid 5-minute averages (75% of the data) are needed to construct a valid 1-hour average.

Data flags are attached to hourly averages under the following conditions:

1. No 5-minute averages are valid.

2. Not all 5-minute averages are valid, but enough are valid (usually ≥ 75%) to meet the validation criteria for a valid hour.

3. Not enough valid 5-minute averages are available to make a valid hour. Hourly average is flagged with appropriate condition flag (power failure, channel down, etc.).

Table 9-1 lists the alarm values and data flags used by NDDN monitoring site data acquisition systems.

Table 9-1. NDDN High and Low Alarm Values and Data Flags

Parameter	Alarm values	
	High value	Low value
Temperature	35°C	-10°C
Delta temperature	+2.5°C	-2.5°C
Relative humidity	102.5%	15%
Solar radiation	1,000 W/m^2	None
O_3	125 ppb	None*
Rain	None	None
Windspeed	10 m/s	None+
Wind direction	None	None
$\sigma\theta$	None	None**
Flow (filter pack)	1.38 Lpm	1.65 Lpm

*A low alarm value of 5 ppb is under consideration
+A low alarm value of 0.3 m/s is under consideration
**A low alarm value of 5° is under consideration

Flags

F = power failure
S = bad status
D = channel downed by operator
C = calibration in process
A = high level alarm
a - low level alarm

B = no samples in averaging period valid
< = samples missing, enough present for valid averages
∧ = out of limits, high
∨ = out of limits, low

Source: ESE, 1987

9.2.1.2.2 Central laboratory validation of field data -- Field data are routinely sent with supporting documentation to the data management center of the central laboratory for validation and storage. Activities usually associated with Level I validation of field data include:

1. Review of submitted data and documentation for completeness. This includes:

    -- Site status report forms
    -- Field logs
    -- Wet deposition report forms (if applicable)

2. Review of site-generated data validation flags (see Section 9.2.1.2.1) for accuracy and completeness. Projects not using the automated flagging of missing data, invalid 5-minute averages, etc., discussed in Section 9.2.1.2.1 must perform those data validation procedures during this Level I validation process.

3. Review of QC checks performed during routine site operation (e.g., instrument zero and span checks).

4. Inspect data for application of correct calibration curves, factors, etc., during data calculation.

5. Review of data for reasonableness (e.g., range and rate of change checks) and agreement with supporting documentation (e.g., site status forms, field logs).

9.2.2 Level II validation. Data submitted to EPA from contractor-operated monitoring projects and data stored in large user data bases (e.g., ADS) are usually Level II validated data.

Activities generally associated with Level II validation of monitoring data include:

1. Review of Level I validation processes for accuracy.

2. Comparison of data collected by the primary DAS with that collected by the backup system. Usually 5 to 10% of the data is compared.

3. Review of QA audit results.

4. Intercomparison of monitoring parameters (e.g., solar radiation and time of day, ozone and temperature).

5. Indepth review of support documentation (e.g., site status forms, field logs) for accuracy and agreement with Level I validated data.

6. Assignment of data flags to data that is:

   -- Invalid
   -- Outside the normal operating range but considered valid
   -- Suspect

9.2.3 Level III validation. Level III validation which deals with evaluation and documentation of the data quality of long-term data sets is beyond this manual's scope.

9.3 Data Storage and Transfer

Upon completion of data validation, the data is stored in the project's data base. The stored data is used to calculate deposition velocities, generate data reports, and produce data summaries.

Transfer of data from one data base to another is a common occurrence in dry deposition monitoring projects. Data is often transferred from:

-- A contractor-operated monitoring project's data base to the sponsoring agency's data base.

-- A local agency's data base to a larger user data base (e.g., ADS).

No matter what mode of transfer is used (e.g., modem, disk, 9-track magnetic tape), it is essential that the data transfer be complete and accurate. To ensure reliable transfer of data from the NDDN's contractor data base to EPA's data base:

1. Data is submitted on two media: 9-track magnetic tape and hard copy printouts.

2. Summary statistics are generated and sent with the tape. When the tape is read into EPA's data base, summary statistics generated from the tape can be compared to those sent by the contractor. If the statistics match, the data has been transmitted completely and accurately. Summary statistics typically include total flag counts by type and parameter averages for each site.

9.4 Quality Control

Quality control activities generally associated with data management include:

-- Use of redundant methods for data collection and transmittal.

-- Use of a redundant two level data validation method where Level II validation includes the review of Level I validation activities.

-- Routine comparison of monitoring data collected by the primary DAS with that collected by the backup DAS.

-- Use of documentation procedures that allow tracking of data throughout the project's measurement process.

-- Adherence to the project's SOP for data management.

9.5 Special Considerations

Pitfalls that commonly affect the quality and usefulness of monitoring data are:

-- The use of data flags that have more than one meaning.

-- Incompatibility of data flags when transferring data from one data base to another.

-- Loss of data usefulness because of inadequate documentation.

-- Loss of data usefulness because of poor validation procedures.

9.6 QA's Role in Data Management

Quality assurance activities during the initial phases of the monitoring project include ensuring that:

-- SOP's for all data management activities (data acquisition, data validation, etc.) are accurate and meet the project's needs.

-- Adequate QC procedures are included in all phases of data management to ensure project quality objectives are being met.

-- Documentation procedures for all data management activities are well defined and meet the project's needs.

-- Data acceptance and validation criteria are well defined and documented.

-- Data management methods (e.g., data collection, data transfer, data storage) will meet the project's quality objectives and needs.

-- Software has been tested and benchmarked using the validation criteria listed for the project.

Once the monitoring project is operating in a routine manner, quality audits of data management activities are conducted on a regular schedule (e.g., every 6 months) to assure generated data:

-- Is of defined quality
-- Meets the project's needs

Both systems and performance audits should be conducted.

9.6.1 Systems audits. Systems audits of data management activities are conducted at project initiation and then on a regular schedule (e.g., annually) for the life of the project. The systems audit is used to verify that:

1. Data management activities are conducted in a timely, efficient, well-documented manner consistent with the project's objectives.

2. Quality control (QC) procedures for the data systems (collection, processing, and storage) are performed in a timely manner and in conformance with the criteria specified in the SOP's.

3. The QC procedures specified for data management activities are adequate to assure the collected data meets the project's quality objectives and needs.

4. Data management is responding to and meeting the project's needs in a timely manner (i.e., monitoring data is received, reviewed, validated, and stored in a timely manner; problems with data collection or processing are reported and corrected, etc.)

Systems auditing of data management activities is usually included as part of the systems audits of laboratory operations and site operations. The data management portion of these audits inspects all aspects of data collection, transfer, validation, and storage.

Listed below are project areas usually covered during a data management systems audit:

1. Organization and responsibility
2. Document control/documentation (especially for computer programs)
3. Training
4. Data reduction, validation, and reporting
5. Maintenance
6. Corrective action
7. Data collection and transfer
8. Traceability
9. Data quality assessment

For the systems audit to be effective, each monitoring project must develop audit procedures and questionnaires that specifically address their project's activities. The above list of activities usually included in the data management systems audit, the discussions on laboratory and monitoring site systems audits given in Sections 8.7.1 and 6.8.1, respectively, and the sample systems audit questionnaires given in Appendices G, H, I, and J can serve as guides in the development of project specific audits.

9.6.1.1 The traceability audit. The traceability audit is usually performed during the systems audit of the project's data management system. Some monitoring projects require traceability auditing of data collected each quarter.

The traceability audit takes a random sample (usually 5%) of Level II validated data and traces the data back along its data path. Each activity performed on that data point is thoroughly investigated for compliance with the project's SOP's. For example, an SO_2 concentration value would be traced back through:

1. Validation -- Did it meet the validation criteria?

2. Analysis -- Did the QC tests, primary standard, calibration curve, etc., used to analyze the sample meet the criteria specified in the SOP?

3. Extraction -- Was the sample extracted in accordance with the SOP? How long was it stored before analysis?

4. Sampling -- Was the monitoring site operating within acceptable limits when the sample was collected? This includes checking that required calibration audits, etc., were performed on schedule and that the site was in compliance at the time.

5. Sample preparation -- Were the sample preparation activities performed in conformance with the SOP? Did the sample's treated filter lot number pass the acceptance testing for treated Whatman filters?

6. Acceptance testing -- Did the sample's untreated filter lot number pass the acceptance testing for Whatman filters?

Any discrepancies found are reported to project personnel for investigation and correction. Some discrepancies may require the review of additional data (e.g., use of incorrect calibration factor).

9.6.2 Performance audits. Data management functions performed during routine laboratory and monitoring site activities are audited during performance audits of the laboratory and sites (see Sections 8.7.2 and 6.8.2).

Data management activities to compile, validate, store, and report data are often overlooked during the performance auditing of data management systems. These data management activities can be performance audited using test data sets produced from actual collected data or synthetically produced data. If the test data is coordinated with QA samples used in performance auditing the laboratory, the data management system can be tested from sample collection through Level II validation of the data.

The test data set usually includes:

1. Continuous monitoring data for all parameters and pollutants collected by the monitoring site. This data should be in the same format as that submitted by the monitoring site.

2. All supporting documentation that normally accompanies submitted data.

3. QA sample materials used to performance test laboratory operations.

4. Calibration curves, factors, etc., needed to calculate data concentrations or values. The data management center can be instructed to use the factors, curves, etc., for a pre-selected site or to use values included with the test data set.

The above test data set should include data that will test the effectiveness and accuracy of the project's data handling systems (e.g., data validation, data flagging, data alarm).

9.6.3 Quality audit results. Auditors usually give a verbal report of findings at the conclusion of the systems audit or send a brief summary report to project personnel at the end of performance audits. A detailed written report of findings usually follows within a reasonable time frame. Any problems, deviations from standard procedures, etc., are brought to the attention of project management for investigation and correction.

9.7 Summary

Data management controls the flow of information between all components of the monitoring project. It is ultimately responsible for all data systems and processes involved in the collection, transfer, review, validation, and storage of monitoring data. An effective, efficient, well-documented data management system is essential to the establishment of a valid, defensible data base of known and acceptable quality.

APPENDIX A

SITING CRITERIA FOR DRY DEPOSITION TRENDS MONITORING NETWORKS

Siting Criteria For Dry Deposition Trends Monitoring Networks

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A-2

SECTION 1

INTRODUCTION

Rising interest in the measurement of atmospheric dry deposition and resultant plans to deploy monitoring stations have generated an awareness of a need for a set of dry deposition siting criteria. Efforts addressing this need have been reported in numerous documents. Unfortunately there is a significant amount of disagreement in the atmospheric measurements community over what constitutes a "good" site. This disagreement is due partly to the differing needs of researchers currently measuring acidic deposition. For example, a site located in an urban area may provide valuable information to a researcher concerned with the deposition induced deterioration of marble and granite buildings but would be of questionable value to a plant pathologist concerned with forest decline. Another, and perhaps more important, cause for the varied opinions on siting criteria is the lack of scientific fact to direct the establishment of siting criteria. The effects of different surface roughnesses on wind patterns is not well understood; thus flat, grass covered areas with no nearby structures are promoted as the ideal site. Although the accuracy of measurements made over this type of terrain may be greater than for other terrain types, flat grasslands are, of course, not representative of all regions.

The purpose of this report is to present a list of dry deposition siting criteria. These criteria have been drawn from the various documents and communications given in the references section as well as from the personal experiences and observations of the authors. The criteria proposed here are intended for use in siting stations in a network designed to monitor large scale, long term trends.

In compiling these criteria, five factors were considered in each instance. These factors are:

- Site Stability
- Site Accessability
- Site Utility Requirements
- Immediate Surroundings
- Regional Character

Site stability, accessability, and utility requirements are factors which are straightforward and require little explanation. They are, however, important considerations and frequently rule out a number of possible sites which would otherwise be ideal.

Siting criteria which address a site's immediate surroundings are primarily targeted at objects which would, in combination with the wind, contaminate or bias the sample. Most of these criteria are taken from documents concerned with precipitation sampling and are in many cases unchanged. Using wet deposition network criteria where applicable will increase the usefulness of data across networks and data bases. Also, there is little evidence to justify changes in most siting criteria. Where changes are suggested from existing wet deposition siting criteria, they are usually increases in minimum allowable distances from possible sources of contamination since these contaminants might have a more pronounced effect on gas and particulate samples than on precipitation.

Evaluating a site's character relative to the region in which it is located is a subjective process. Criteria addressing regional representativeness cannot be and should not be written with the same specificity as other criteria because of the differences among regions. These criteria are designed to be flexible and serve more as guidelines for documentaion. Included are local source effects such as those resulting from a site's proximity to a power plant. The question of how to site a dry deposition station relative to a strong point-source such as a coal-fired power plant can serve to illustrate the rationale used to derive regionally representative criteria.

In a region with no large cities or industry, a single power plant 10 miles from a sampling site could significantly bias the site's data. In such a situation, a criteria requiring, for example, a minimum separation of 20 miles (or 40 miles if the site is downwind of the power plant) is reasonable. However, in a more developed region this criterion would not be reasonable because of the density of industries and utilities. For this reason it is suggested that a well thought out criterion should consider the percent impact on regional background pollutant levels. A source-induced bias of 20 percent in a developed region is certainly more acceptable than a 200 percent bias in a rural region.

Siting criteria should be applied so that positive and negative biases are avoided. Siting criteria, when properly applied, should lead to the selection of sampling locations which reflect the mean air quality of the region. Section 2 contains a list of siting criteria to aid in the selection and evaluation of dry deposition monitoring sites.

SECTION 2

DRY DEPOSITION SITING CRITERIA

1. The steepest slope of the ground within 30 meters of the collector should be less than 20 degrees and should be less than or equal to slopes typical of the regional terrain.

2. Surrounding vegetation within 500-m of the site should be typical of vegetation in the region.

3. In a forest setting, the station should be located in a clearing at least 50-m from the woodline.

4. The distance from the collector to the nearest solid structure smaller than 3 m x 3 m x 3 m should be at least 10-m.

5. The distance to the nearest solid structure larger than 3 m x 3 m x 3 m should be at least 20-m.

6. The distance to the nearest residence of height, h, should be at least 5 h.

7. The distance to the nearest grazing domesticated animals should be at least 50-m.

8. The distance to the nearest cultivated field where tilling and fertilization are done by tractor application should be at least 50-m.

9. The distance to the nearest edge (i.e., large lake, ocean, cliff, etc.) should be at least 5-km.

10. The distance to the nearest source such as a landfill or sewage treatment facility should be at least 500-m.

11. The distance to open surface storage of agricultural products, fuels, or vehicles should be at least 100-m.

12. Sources of fugitive dust (such as aerial crop dusting, spraying, or fertilizing) should be at least 500-m.

13. The distance to the nearest large concentration of animals such as dairy feedlots should be at least 500-m.

14. The nearest parking lot containing fewer than 10 cars, and where traffic movement is limited to a few brief episodes daily (people coming to and leaving work) should be at least 100-m.

15. The nearest large parking area (> 20 cars) or smaller parking area with frequent use, vehicle or equipment service area should be at least 150-m.

16. The distance to the nearest regularly traveled road carrying < 10 cars/hr (a driveway or jeep trail, traveled only to reach the site is an exception; however it should be no nearer than 10-m to the collector) should be at least 150-m.

17. The distance to the nearest state or secondary road (carrying between 20 and 200 cars/hr) should be at least 200-m.

Note: For questions 18 thru 23 the **minimum** distances are to be doubled if the source is upwind of the collection site. If the region is predominantly urban the **minimum** distances are to be reduced by half.

18. The distance to the nearest small community (100-1,000 pop.) should be at least 0.75-km.

19. The distance to the nearest urban area (1,000-10,000 pop.) should be at least 1 km.

20. The distance to the nearest urban area (10,000-75,000 pop.) should be at least 5-km.

21. The distance to the nearest urban area (> 75,000 pop.) should be at least 10-km.

22. The distance to the nearest major industrial source such as a power plant, foundry, or chemical plant should be at least 10-km.

23. The distance to the nearest interstate highway, major thoroughfare, major airport, or railroad complex should be at least 2-km.

APPENDIX B

SITING CRITERIA FOR REGIONALLY LOCATED WET DEPOSITION COLLECTION SITES

Siting Criteria for Regionally Located Wet Deposition Collection Sites

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SITING CRITERIA FOR REGIONALLY LOCATED WET DEPOSITION COLLECTION SITES

This report contains a list of siting criteria to be used in selecting or evaluating regionally located precipitation collection sites in rural regions of the State-Operated Network. For purposes of this discussion, a regionally located site is characterized as one located in a rural area, at least 5 km distant from urban centers of 10,000 inhabitants, and at least 10 km distant from major industrial sources or urban centers of 75,000 inhabitants. A companion report (1) lists criteria for sites which are, by design or necessity, urban-influenced or are purposefully located within urban areas[1].

The general objective of a regionally located site is to obtain precipitation data that is representative of a large geographic area and from this data identify long-term temporal and spatial variations in the chemical nature of precipitation.

The criteria are grouped in three categories which address influences on the sample collection from the point of view of (1) nearby site influences, (2) local influences, and (3) regional influences. Information contained in the criteria is primarily based on that given in four documents: the EPA "Quality Assurance Handbook for Air Pollution Measurement Systems," Volume I, Principles[2] the EPA "Quality Assurance Manual for Precipitation Measurement Systems"[3]; the U.S. Geological Survey document, "Design of the National Trends Network for Monitoring the Chemistry of Acid Precipitation"[4]; and the "NADP Instruction Manual: NADP/NTN Site Selection and Installation"[5].

The siting criteria may be used to evaluate the suitability of an existing or candidate wet-only regionally representative precipitation collection site in terms of:

- type and height of groundcover in the immediate vicinity of the location of the sampling equipment (important to avoid sample contamination from the soil and plants);
- distance of the sample collection equipment from obstructions (important to avoid sample contamination and variation in sample catch efficiency);
- distance of the sample collection equipment from nearby and distant sources of contamination and pollution (important to avoid undue source influences on the sample's constituent concentrations which, if present, make the sample less representative of the region);
- human or animal activities in the vicinity of the collection site (important to avoid sample contamination); and

- topographic, hydrologic, and orographic features of the land surrounding the site (important for regional representativeness, catch efficiency, avoidance of sample contamination, and desirable collector sensor operation).

This section on siting criteria for rural wet deposition collection sites is to be used in quality assurance studies of State-Operated Network sites, as discussed in the work plan for this effort.[6]

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5. Bigelow, D. S. NADP Instruction Manual: NADP/NTN Site Selection and Installation. National Atmospheric Deposition Program Coordinator's Office, Colorado State University, Fort Colllins, Colorado, July 1984.

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REGIONAL SITING CRITERIA

SITE INFLUENCES

1. The steepest slope of the ground within 30 meters (98 ft.) the collector and rain gauge should be less than 20 degrees and will be less than or equal to slopes typical of the regional terrain unless the site is on a hilltop. The slope should then be less than 30 degrees. Ideally, the slopes should be less than 5 degrees. The collector and rain gauge should be mounted at ground level or on platforms of small surface area and of height generally no more than 1 m (3.3 ft.). The openings of the collector and gauge should be level and at the same height above ground within 0.5 m (1.6 ft.). The separation distance between collector and gauge should be at least 5 m (16.4 ft.) and no more than 30 m (98 ft.) unless they are mounted on a platform as is required in high snowfall areas.

2. The distance to collocated equipment should be at least 5 m (16 ft.).

3. Surrounding vegetation within 500 m (1640 ft.) of the site should be typical of vegetation in the region. The height of ground cover should be no higher than 0.6 m (2 ft.) within a circle of 10 m (33 ft.) radius surrounding the collector.

4. In a forest setting, the site should be located in a clearing at least 30 m (98 ft.) from the woodline. In no case, should the angle of projection of a tree onto the collector or rain gauge rim be greater than 45 degrees.

5. The distance from the collector to the nearest solid structure (house, shed, wall, etc.) should be great enough so that the object occupies less than 30 degrees arc as viewed from the collector. The angle of projection from the top of a solid structure should not exceed 15 degrees.

6. The distance from the site to the nearest grazing domesticated animals should be at least 20 m (66 ft.).

7. The distance from the site to the nearest cultivated field should be at least 20 m (66 ft.).

LOCAL INFLUENCES

8. The distance from the site to the nearest source, such as a landfill or sewage treatment facility, should be at least 100 m (328 ft.).

9. The distance from the site to open surface storage of agricultural products, fuels, or vehicles should be at least 100 m (328 ft.).

10. The distance from the site to sources of fugitive dust (such as a cement plant or granary should be at least 500 m (1,640 ft.).

11. The distance from the site to the nearest large concentration of animals, such as dairy feedlots, should be at least 500 m (1,640 ft.).

12. The nearest parking lot containing fewer than 10 vehicles, and where traffic movement is limited to a few brief episodes daily (people coming to and leaving work) should be at least 75 m (246 ft.) from the collector.

13. The nearest large parking area (> 20 vehicles), smaller parking area with frequent use, or vehicle and equipment service area should be at least 100 m (328 ft.) from the collector.

14. The nearest regularly traveled road carrying less than 30 vehicles/hr (24 hr. average) should be at least 50 m (164 ft.) from the collector. A driveway or jeep trail, traveled only to reach the site, is an exception; however, it should be no nearer than 10 m (33 ft.) to the collector.

15. The distance from the site to the nearest state or secondary road carrying over 30 vehicles/hr should be at least 100 m (328 ft.).

REGIONAL INFLUENCES

16. The distance from the collector to oceans or saltwater bodies which may contribute significant salt spray should be at least 2 km (1.2 mi.).

17. The distance from the site to the nearest small community (100-1000 pop.) should be at least 0.75 km (0.5 mi).

18. The distance from the site to the nearest urban area (1,000-10,000 pop.) should be at least 1 km (0.6 mi).

19. The distance from the site to the nearest urban area (10,000-75,000 pop.) should be at least 5 km (3 mi).

20. The distance from the site to the nearest urban area (> 75,000 pop.) should be at least 20 km (12 mi).

21. The distance from the site to the nearest major industrial source such as a coal or oil burning power plant, foundry, chemical plant, etc., should be at least 10 km (6 mi).

22. The distance from the site to the nearest interstate highway, major thoroughfare, major airport, or railroad complex should be at least 2 km (1.2 mi).

APPENDIX C

SITING CRITERIA FOR URBAN-INFLUENCED WET DEPOSITION COLLECTION SITES

Siting Criteria for Urban-Influenced Wet Deposition Collection Sites

By

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DISCLAIMER

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SITING CRITERIA FOR URBAN-INFLUENCED WET DEPOSITION COLLECTION SITES

This report contains a list of siting criteria to be used in selecting or evaluating urban-influenced or urban-located State-Operated Network (SON) precipitation collection sites. The criteria are to be used in quality assurance studies of SON sites, as discussed in the work plan for this effort[1]. An urban-influenced site is one that is located closer than 5 km to an urban center of 10,000 to 75,000 inhabitants or closer than 10 km to a major industrial source or an urban center of 75,000 or more inhabitants. The site may also be in the urban center proper.

The general objective of an urban or urban-influenced site is to obtain precipitation data that is representative of the urban area and from that data to identify both short- and long-term temporal and spatial variations in the chemical nature of precipitation and their relationship to sources in the urban area.

The criteria are grouped into categories which address urban influences on the sample collection with respect to nearby site and local influences. Information and guidance contained in the criteria are based on experience, observations, and that given in: quality assurance and siting documents published by EPA[2,3,6,7,8]; the U. S. Geological Survey document, "Design of the National Trends Network for Monitoring the Chemistry of Acid Precipitation"[4]; the "NADP Instruction Manual: NADP/NTN Site Selection and Installation"[5]; a World Health Organization publication[9]; several World Meteorological Organization publications[10,11,12]; several books[13,14]; and personal communication[15].

The siting criteria may be used to evaluate the suitability of an existing or candidate wet-only urban-influenced precipitation collection site in terms of:

- type and height of groundcover in the immediate vicinity of the proposed location of the sampling equipment (important to avoid sample contamination from the soil, plants, or structures);
- distance of the sample collector equipment from obstructions (important to avoid sample contamination and variation in sample catch efficiency);
- distance of the sample collection equipment from nearby sources of contamination and pollution (important to avoid undue source influences on the sample's constituent concentrations which, if present, make the sample less representative of the area);
- human or animal activities in the vicinity of the collection site (important to avoid vandalism and sample contamination); and

- topographic, hydrologic, and orographic features of the land and buildings surrounding the site (important for representativeness, catch efficiency, avoidance of sample contamination, and desirable collector sensor operation).

The siting criteria given in this report are similar to those for the regionally located sites, with the exception that certain distance requirements for local influences are somewhat relaxed and siting recommendations specific to city-located collectors have been added.

The distribution of airborne pollutants and rainfall amount within a city can vary widely. Underlying reasons for this are the wide variety and strength of sources, micrometeorological effects caused by structures, the city's heat island effect, and the much larger number of condensation nuclei present in and downwind of cities as compared to rural areas. For these reasons, the representativeness of a city-based precipitation collection site should be determined.

Site selection within a city or in an urban-influenced area should also consider the possibility of new construction or major renovation in the local area, the weather and conditions in both cold and warm seasons, the elevation and topography of the land, and the availability of meteorological information.

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URBAN SITING CRITERIA

SITE INFLUENCES

1. The steepest slope of the ground within 30 m (98 ft) of the precipitation collector and rain gauge should be less than 20 degrees and should be less than or equal to slopes typical of the general terrain unless the site is on a hilltop. The slope should then be less than 30 degrees. The openings of the collector and gauge should be level and at the same height above ground, within 0.5 m (1.6 ft). The separation distance between collector and gauge should be at least 5 m (16 ft) and no more than 30 m (98 ft) unless they are mounted on a platform in high snowfall areas.

2. If the collector must be located on a rooftop of a building, apply the same criteria for obstructions as if the site were at ground level. The roof should be approximately the same height as those of surrounding buildings, level, and its surface free of dusty materials. Buildings of one to three stories in height are preferred. The collector should be located near the center of the roof and as far as possible from exhaust or inlet vents, chimneys, or overhead wires. Be cognizant of chimneys, exhausts, etc. on adjacent buildings.

3. Surrounding vegetation, land features, and structures within 500 m (1,640 ft) of the site should be typical of those in the urban area. The height of the ground cover should be no greater than 0.6 m (2 ft) within a circle of 10 m (33 ft) radius surrounding the collector.

4. No object (overhead wire, tree, building, etc.) should project onto the collector at an angle greater than 45 degrees.

5. In a wooded setting, the site should be located in a clearing at least 30 m (98 ft) from the woodline.

6. The distance from the collector to the nearest solid structure (house, shed, wall etc.) should be great enough so that the object occupies less than 30 degrees of arc viewed from the collector. The angle of projection from the top of a solid structure should not exceed 15 degrees.

LOCAL INFLUENCES

7. The distance from the site to the nearest source, such as a landfill or sewage treatment facility, should be at least 100 m (328 ft).

8. The distance from the site to open surface storage of agricultural products, fuels, or chemicals should be at least 100 m (328 ft).

9. The distance from the site to sources of fugitive dust such as a cement plant should be at least 200 m (656 ft).

10. If the site is a ground level, the nearest large parking area (> 20 vehicles), smaller parking area with frequent use, or vehicle and equipment service area should be at least 30 m (98 ft) from the collector.

11. The nearest regularly traveled road carrying < 120 vehicles/hr (24 hr average) should be at least 30 m (98 ft) from the collector. A driveway, tra-

veled only to reach the site, is an exception; however, it should be no nearer than 10 m (33 ft) to the collector.

12. The distance from the site to the nearest state or secondary road carrying over 120 vehicles/hr (24 hr average) should be at least 50 m (164 ft). The collector should not be located alongside heavily traveled city streets at ground level.

13. Distance from the collector to oceans or saltwater bodies which may contribute significant salt spray should be at least 2 km (1.2 mi).

14. The distance from the site to the nearest major industrial source, such as a coal or oil burning power plant or foundry should be at least 3.2 km (2 mi).

15. The distance from the site to the nearest interstate highway, major thoroughfare, major air port, or railroad complex should be at least 1 km (0.6 mi).

APPENDIX D

NDDN-SITE SUITABILITY EVALUATION FORM

EPA/NDDN/EVAL/FORM.1
REV.01--11/86

NDDN-SITE SUITABILITY EVALUATION FORM

____
Date Prepared

____
Reason (New site, change, revision)

A. SITE IDENTIFICATION

1. Station______________________ 2. County__________ 3. State______

4. SAROAD code__________________ 5. CAL code__________________

6. Operating Agency______________________________________

7. Funding Source______________________________________

8. Site Ownership______________________________________

9. Latitude_____°_____' 10. Longitude_____°_____' 11. Elevation_____(m)

12. Available USGS Topographical Map (1:24,000 preferred) (Yes No) (circle) 13. ________ Revision Year 14. ______ Scale

15. Map Name______________________________________

B. ADMINISTRATION

1. Site Operator______________________________________

   ____
   Mailing Address To Which UPS Will Deliver Buckets

   ____

   Phone_____/________________

2. Site Operator's Supervisor ______________________________

   Mailing Address______________________________
   (number--street)

   ____
   (city--state) (zip code)

   Phone_____/________________

3. ______________________________________
   Supervisory Official Who Will Receive Preliminary Data Reports

   Mailing Address______________________________
   (number--street)

   ____
   (city--state) (zip code)

   Phone_____/________________

C. LOGISTICS

1. Site stability (ownership) ______________________________
2. Zoning (changes expected?) ______________________________
3. Special use permits ______________________________
4. Operator availability ______________________________
5. Funding mechanism ______________________________
6. Road access to site

   Summer - good fair poor
   Winter - good fair poor

7. Comments ______________________________
____

8. Road surface ____________________
9. Distance to site ____________ (m)
10. How close to site ____________ (m)
11. Elecrical power Volts __________ Amps __________
    Distance __________ Other considerations __________

12. Utility Co. ____________________ ____________________
    Telephone No. ____________________ ____________________

13. Telephone service Dedicated line ____________________
    Proximity of line ____________________
14. Telephone Company ____________________
    Telephone No. ____________________

15. Site security (describe) ______________________________
____

16. Objections to fencing? ______________________________
____

EPA/NDDN/EVAL/FORM.2
REV.01--11/86

C. INSTRUMENTATION AT OR NEAR THE SITE

1. Precipitation at the site:

a. Required Raingage (Co-located within 30 meters of the NADP Collector)
Type:

None____ Recording_____ Non-Recording_____

Weighing_____ Tipping Bucket_____ Other_________________________

Opening_____(cm) Manufacturer_______________ Model_______________

Equipped with event recorder____Yes ____No

Background:

Distance________(m) Direction______ Alter Shielded____yes____no

Years______ Annual Precipitation________/________/________(mm)
Total Rain Snow Depth

b. Alternate Nearest Gage

____Years____________
(Location)

Distance_________(km) Direction__________

Annual Precipitation_________/_________/_________(mm)
Total Rain Snow Depth

2. Wind at Site:

a. Wind (Co-located within 0.5 km of the NADP Collector)

None____ Recording ____ Non-Recording____ Speed____

Manufacturer____________ Model____________

Distance_________(m) Direction__________

Height above ground _________(m) _________(m) (m)

(Please attach wind rose if available)

b. Alternate Nearest Measurement

____
(Location)

Distance_________(km) Direction_________W

(Please attach wind rose if available)

EPA/NDDN/EVAL/FORM.3
REV.01--11/86

D. RELATED SCIENTIFIC ACTIITIES

1. Additional Sampling:

a. Aerosol Samplers

(1) Check those aerosol samplers co-located within 0.5 km of the NADP Sampler.

____Inertial Cascade Impactor
____Integrating Nephelometer
____Hi Volume Filter
____Other

____Dichotomous Particulate Sampler
____Inhalable Particulate Sampler
____Condensation Nucleous Counter
____Aerosol Size Analyzer
____Membrane Filter & Vacuum Pump

Fluoride (Static Sample)

____

____

(2) What chemical constituents on the filters are analyzed?

____

(3) By what analytical technique and/or through what agency?

____

____

b. Gas Measurements

(1) Check those gas measurements made within 0.5 km of your NADP collector.

EPA/NDDN/EVAL/FORM.4
REV.01--11/86

c. Meteorological instruments

(1) Check those meteorological instruments co-located within 0.5 km of the NADP sampler, that are in addition to the previously described rain and wind instrumentation.

2. Associated acid rain effects research going on within 0.5 km radius (Project:Sponsor:Principal Investigator:Address)

____

____

____

3. Does a calibrated watershed exist within 0.5 km of site? NO._____

Area__________Hectares

Method of flow gaging _____________

Slopes _______________

Kind of chemical analysis performed ____________________

Covertype______________

4. If other air quality or precipitation chemistry data or publications specific to the site are available, please describe:

____

____

____

____

EPA/NDDN/EVAL/FORM.5
REV.01--11/86

E. POTENTIAL LOCAL CONTRIBUTORS TO DEPOSITION AT THE SITE

1. Within 30 m of the SAMPLER identify all objects that are taller than the sampler.

a. Structures None

1) Type__________________ Use____________________________
Height________(m) Distance________(m) Direction________
2) Type__________________ Use____________________________
Height________(m) Distance________(m) Direction________

b. Trees None

1) Species __________________ Max. Height _____________(m)
Distance _____ (m) Direction _________
2) Species____________________Max. Height______________(m)
Distance______(m) Direction_________
3) Species____________________Max. Height______________(m)
Distance______(m) Direction_________

c. Other (e.g., overhead wires, masts, etc.)

1) Object____
Height_______(m) Direction________ Distance_______(m)
2) Object____
Height_______(m) Direction________ Distance_______(m)
3) Object____
Height_______(m) Direction________ Distance_______(m)
4) Object____
Height_______(m) Direction________ Distance_______(m)
5) Object____

d. Is public road access to site in
summer:____Good, ____Fair, ____Poor?
and winter:____Good, ____Fair, ____Poor?

e. Type of public road surface?_________________________________

f. How far from the public road will collector be sited?_________(m)

g. Is there other than public road access to the site? If so, please describe.

____

____

____

h. How close can a vehicle approach the collector? ______________(m)

i. How is site secured against vandalism, etc.? ____________________

j. Are there any special logistical problems? Please describe.

____

____

____

2. Within 200 m of the site identify:

a. Predominate land use in the area:

Use 1________, _____% Use 2 ________, ____% All others______%
(cultivated, orchard, lawn, pasture, forest, water,
swamp, residential)

b. Unpaved roads and parking areas: None

1) Unpaved road: Distance______(km,m) Direction from sampler_____
Traffic: Heavy______, Medium______, Light______

2) Unpaved road: Distance______(km,m) Direction from sampler_____
Traffic: Heavy______, Medium______, Light______

1) Parking lot: Distance______(km,m) Direction from sampler______
Unpaved________ Surface material________
Use: continuous________ intermittent_______ car volume________
large truck volume________

2) Parking lot: Distance______(km,m) Direction from sampler______
Unpaved________ Surface material________
Use: continuous________ intermittent_______ car volume________
large truck volume________

3. Within 1 km of the site identify significant agricultural operations such as feedlots, dairy barns, cultivated fields, etc.

Type ______________________________________

Distance______((km,m) Direction from sampler_____

Type_______________________________________

Distance______((km,m) Direction from sampler_____

4. Within 10 km of the site, identify transportation related sources.

a. Main highways or expressways: Traffic volume____________________
Direction from sampler________ Distance_____(km,m) Route #_______
Main highways or expressways: Traffic volume____________________
Direction from sampler________ Distance_____(km,m) Route #_______

b. Other paved roads: Distance(km,m) Direction from sampler
Traffic: Heavy_____, Medium_____, Light_____ Traffic Volume_____
Other paved roads: Distance______(km,m) Direction from sampler___
Traffic: Heavy_____, Medium_____, Light_____ Traffic Volume_____

c. Lake/river or rail traffic: None
Distance____(km,m) Direction from sampler________
Barge_____, lake steamer_____, ocean vessels_____, rail_____
Traffic: Heavy_____, Medium_____, Light_____, Traffic Volume____

d. Airport: Distance_____(km,m) Direction from sampler________
Traffic: Heavy_____, Medium_____, Light_____

e. Other transportation related sources____________________________
____
____

5. Within 60 km of the site identify stationary sources:

a. Power plant(s):
1) Name____
Distance_____(km) Direction from sampler________
Fuel________ Electrical capacity_________________(KW_e, MW_e)
2) Name____
Distance_____(km) Direction from sampler________
Fuel________ Electrical capacity_________________(KW_e, MW_e)
3) Name____
Distance_____(km) Direction from sampler________
Fuel________ Electrical capacity_________________(KW_e, MW_e)

b. Industry:

1) Type/product____
Distance_____(km) Direction from sampler_____
Comment____

2) Type/product____
Distance_____(km) Direction from sampler_____
Comment____

c. Other stationary sources:

Type Product_____________________Distance______ Direction________
____
____
____
____

6. Within 60 km of the site identify significant area sources: None

Type______________________________ Distance______ Direction________
____
____
____

F. GEOLOGY

1. Soil type: Armour silt loam and Stasser silt loam
Within 1 km of site_________________________
(Please attach soils map if available)

G. LABORATORY FACILITIES

1. Available Lab Space: None_____ Good_____ Fair_____ Poor_____
Distance____________(km) Shared: _____Yes _____No
2. pH Meter: None _____ Manufacturer_________________Model_____________
Probe_______________ Manufacturer_________________Model_____________
3. Conductivity Meter: None______ Manufacturer_____________Model________
Probe_______________ Manufacturer_________________Model_____________
4. Balance______ None______ Manufacturer_______________Model_____________
5. Type of low conductivity water available:
deionized______ distilled______ bottled______
6. Special problems: ____
____

EPA/NDDN/EVAL/FORM/B.0
REV.01--11/86

SURROUNDING TERRAIN AND OBSTRUCTIONS

Clinometer Readings

Direction (°)	Ground Slope	Clinometer Reading (°)	Objects	Distance (m)
0 (N)				
45 (NE)				
90 (E)				
135 (SE)				
180 (S)				
225 (SW)				
270 (W)				
315 (NW)				

Other Structures

Direction (°)	Clinometer Reading (°)	Distance (m)	Structure

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H. OTHER

1. Topographic map, listed in Section A11-14.
   Enclosed ____
   Will send ____
   Not available ____

2. Photos of the site in the 8 directions.
   Enclosed ____
   Will send ____
   Not available ____

3. A scale drawing of the site to 30 meters where 1 cm = 10 ft.
   Enclosed ____
   Will send ____
   Not available ____

(Include all items on the map identified in Sections C1 and E1)

I. PERSON WHO FILLED OUT THIS FORM:

Name ________________________________
Position ________________________________
Phone # ________________________________
Address ________________________________
____
____

APPENDIX E

NDDN SITE ACCEPTANCE CHECKLIST

NDDN SITE ACCEPTANCE CHECKLIST

SITE NAME________________________________NUMBER______________

LOCATION____

DATE__________________________

METEOROLOGICAL TOWER

__ Tower set in concrete
__ Tower vertical
__ Guy wires attached at least 2/3 tower height @ 45 degree angle
__ Guy wires fastened with two clamps at each end
__ Guy wires attached to appropriate anchors (screw type or triangular plate)
__ All wires attached firmly to tower with tie wraps
__ Lighting kit attached
__ Cable support wire from met tower to shelter
__ Sensors vertical on crossarm
__ Temperature shields at 2 meters and 9 meters.
__ Shields pointing North
__ Crossarm pointing North
__ Directional landmarks indicated

DRY DEPOSITION TOWER

__ Tower set in concrete
__ Tower vertical
__ Guy wires attached at top of stationary section @ 45 degree angle
__ Guy wires fastened with two clamps at each end
__ Guy wires attached to acceptable anchors (as above)
__ Sample lines fastened securely to tower and not contorted when tower is raised or lowered
__ Sample lines supported with wire between tower and shelter
__ Tower locked in vertical position
__ Lanyard securely tied to tower

RAIN GAUGE (TIPPING BUCKET)

__ Mounted on single aluminum pole
__ Gauge inlet @ 1 meter height
__ Base mounted in concrete
__ Signal cable buried
__ Rain gauge level
__ Mounted away from any obstruction with an angle not greater than 20 degrees to any structure
__ Good judgement used in gauge location
__ Heater cable installed/buried

SOLAR RADIATION SENSOR

__ Mounted on single aluminum pole set in concrete
__ Sensor mounted to South of shelter and towers
__ Good judgement used in sensor location
__ Not more than a 20 degree angle to any structure
__ Sensor level
__ Signal cable buried
__ Sensor height 1 meter

SHELTER

__ Mounted on concrete pad or pylons
__ Shelter fastened to pad or pylons
__ Shelter level
__ No step greater than 8 inches at shelter entrance
__ Air conditioning/heater working properly
__ External power outlet
__ External light
__ Electrical ground
__ Keys left on site (with operator)
__ Has the orientation been standardized (e.g. door facing east)
__ Lock installed

INSTRUMENTATION/OPERATION

__ Sample lines insulated/leak tested
__ Knockout bottles installed clamped/greased
__ Instruments operational: ___ ozone analyzer ___ mass flow controller ___ dry deposition pump ___ day/night solenoid ___ zero air supply ___ DSM 3260 ___ DSM 3260L ___ computer ___ meteorological instruments
__ Min/max thermometer
__ Station log book
__ Filing system: ___ phone log ___ ozone calibrations ___ flow calibrations ___ meterological calibrations ___ transfer standard certifications
__ Julian calendar
__ Maintenance schedule
__ Site inventory
__ Spare parts inventory
__ Site description including site photos and map
__ DSMREAD and DSMTALK software
__ Data diskette supply (10)
__ Telephone
__ Modem
__ Tool kit
__ Multimeter
__ SOP manual/checklist

SAFETY EQUIPMENT

__ Fire extinguisher
__ Emergency light
__ Climbing belt
__ Emergency phone list

____
Site Operator (PRINT)

______________________________ _______________
Site Operator (SIGN) Date

____
ESE Representative (PRINT)

______________________________ _______________
ESE Representative (SIGN) Date

APPENDIX F

NDDN FIELD PERFORMANCE AUDIT OBSERVABLES

Table 10-1. Field Performance Audit Observables

Observable	Measurement Device	Performance Test Frequency	Performance Standard	Calibration Frequency	Calibration Standard	Audit Frequency	Audit Standard	Primary
Windspeed	Anemometer Climatronics	Weekly	Visually check anemometer speed, compare with observed windspeed and recorded value	Quarterly	NBS-traceable anemometer	Semiannual	Constant-rpm motor	Yearly factory recertification
Wind Direction	Vane Climatronics	Weekly	Visually check wind vane direction, compare with recorded value	Quarterly	Alignment with true north	Semiannual	Brunton compass	Second-order theodolite
Air Temperature/ Delta Temperature	Resistance thermometer Climatronics	Weekly	Electronic check	Quarterly	NBS-traceable thermometer	Semiannual	Assman psychrometer	NBS-traceable thermometer
Humidity	Strain gauge Climatronics	Monthly	Psychrometer	Quarterly	Assman psychrometer	Semiannual	Assman psychrometer	NBS-traceable thermometer
Solar Radiation	Pyranometer Climatronics	Weekly	Compare recorded value with observed solar intensity; zero check	Quarterly	Eppley radiometer	Semiannual	Eppley radiometer	Yearly factory calibration of transfer standard
Precipitation Measurement	Tipping-bucket rain gauge Climatronics	Weekly	Manual tip check	Quarterly	Addition of known volumes	Semiannual	Addition of known volumes	NBS-traceable volumes
Precipitation Collection	Aerochem-Metrics collector	Weekly	Wet sensor, measure time lid remains open	Quarterly	Wet sensor, measure time lid remains open	Semiannual	Wet sensor, measure temperature of sensor with thermistor, record time lid remains open	NBS-traceable thermometer

Table 10-1. Field Performance Audit Observables (Continued, Page 2 of 2)

Observable	Measurement Device	Performance Test Frequency	Performance Standard	Calibration Frequency	Calibration Standard	Audit Frequency	Audit Standard	Primary
Ozone	Fluorescence Thermo Electron	Weekly	Zero, span, and precision	Quarterly	NBS-traceable ozone generator	Semiannual	Thermo Environmental 49-103P	Photometer at USEPA, RTP, NC
Filter Pack Flow	Filter pack mass flow controller	Weekly	Check recorded flow value, compare with set value, leak check	Quarterly	Tylan mass flow meter	Semiannual	Tylan mass flow meter	NBS-traceable Tylan mass flow meter

Source: ESE, 1988.

APPENDIX G

NDDN FIELD SYSTEMS AUDIT REPORT FORM

FIELD SYSTEMS AUDIT REPORT FORM

1.0 MONITORING SITE

1.1 Site Name: ______________________________

1.2 Date of Audit: ______________________________

1.3 Auditor: ______________________________

1.4 Site Operator: ______________________________

2.0 SITE LOCATION

2.1 USGS map for the site: ______________________________

2.2 Declination: __________ E/W

2.3 Target Number 1:

2.4 Bearing to Target 1: __________ Mag __________ True

2.5 Target Number 2:

2.6 Bearing to Target 2: __________ Mag __________ True

2.7 Latitude __________ W, Longitude __________ N

2.8 UTM coordinates:

Zone __________, East __________m, North __________m

2.9 Elevation: ________

2.10 Compare site description location:

Site description: Latitude __________, Longitude __________

UTM: Zone __________

East __________m, North __________m

Elevation __________

Figure A-1
FIELD SYSTEMS AUDIT REPORT FORM

U. S.
Environmental Protection Agency

National Dry Deposition
Network

3.0 SITE DESCRIPTION DOCUMENTATION

3.1 Date of latest revision: ______________________________

3.2 Compare photographs to surroundings and note changes: __________
____
____

3.3 Are changes documented in Site Description including date of change? ______________________________

4.0 SITING CRITERIA

4.1 Large point source of SO_x and NO_x:
Description: ______________________________
____
Distance: ______________________________
Direction: ______________________________

4.2 Major industrial complex:
Description. ______________________________
____
Distance: ______________________________
Direction: ______________________________

4.3 Major highway:
Description: ______________________________
____
Distance: ______________________________
Direction: ______________________________

4.4 Major airport:
Description: ______________________________
____
Distance: ______________________________
Direction: ______________________________

Figure A-1.
Field Systems Audit Report Form

4.5 Major railyard:
Description: ______________________________
____
Distance: ______________________________
Direction: ______________________________

4.6 Heavily traveled secondary road:
Description: ______________________________
____
Distance: ______________________________
Direction: ______________________________

4.7 Lightly traveled secondary road:
Description: ______________________________
____
Distance: ______________________________
Direction: ______________________________

4.8 Feedlot operations:
Description: ______________________________
____
Distance: ______________________________
Direction: ______________________________

4.9 Intensive agricultural operations:
Description: ______________________________
____
Distance: ______________________________
Direction: ______________________________

4.10 Limited agricultural operations:
Description: ______________________________
____
Distance: ______________________________
Direction: ______________________________

4.11 Large parking lot:

Description: ______________________________

____

Distance: ______________________________

Direction: ______________________________

4.12 Small parking lot:

Description: ______________________________

____

Distance: ______________________________

Direction: ______________________________

4.13 Tree line:

Description: ______________________________

____

Distance: ______________________________

Direction: ______________________________

4.14 Obstacle larger than 3 m^3:

Description: ______________________________

____

Distance: ______________________________

Direction: ______________________________

4.15 Obstacle smaller than 3 m^3:

Description: ______________________________

____

Distance: ______________________________

Direction: ______________________________

5.0 LOCAL SURROUNDINGS

5.1 Is air flow restricted in any direction? ______________

5.2 What is distance and direction to trees and their heights?

____

5.3 What is distance and direction to obstacles such as buildings? ________________

5.4 What is height of obstacle in 5.3? ________________

5.5 What is distance and direction to roadways? ________________

5.6 Estimate average daily traffic: ________________

5.7 What is composition of roadway (e.g., concrete, asphalt, gravel, dirt) ? ________________

5.8 What local sources are nearby (e.g., concrete, asphalt)? ________________

5.9 What is surrounding ground cover (e.g., grass, brush, forest, sand)? ________________

6.0 STATION FACILITIES

6.1 What is approximate shelter size? ________________

6.2 Is shelter protected with locked fence? ________________

6.3 Does meteorological tower have anti-climb devices? ________

6.4 Is ladder firmly attached to shelter? ________________

6.5 Are all external apparatus adequately secured? ________

6.6 How much space is available for:

Operation? ________________

Calibration checks? ________________

Data reporting? ______________________________

Instrument maintenance? ______________________________

6.7 How is shelter temperature maintained? ____________________

6.8 What are shelter temperature limits? ____________________

6.9 Is a calibrated thermometer onsite? ____________________

6.10 Does this site experience malfunctions due to electric power fluctuations or outages? ____________________

6.11 What tools are available onsite? ____________________

____

6.12 What spare parts are kept onsite? ____________________

____

7.0 SPECIFIC INSTRUMENTS

7.1 Ozone Analyzer:

7.1.1 Manufacturer/model: ____________________

7.1.2 Serial number: ____________________

7.1.3 Are procedures that cover operation, maintenance, performance checks, and calibrations to be performed by the Site Operator available onsite? __________

7.1.4 Diagram the ozone sampling system including performance check system:

7.1.5 Estimate length and diameter of sampling manifold from inlet to exhaust: ____________________

7.1.6 Is manifold clean? ____________________

7.1.7 How often is manifold cleaned and date of last cleaning?

____

7.1.8 Flow rate in manifold:

What is flow rate? ____________________

How is it maintained? ____________________

How is it checked for amount and direction? __________

____

How often is it checked? ____________________

7.1.9 What are materials of manifold and probes? __________

____

7.1.10 Estimate length and diameter of sampling probes to instruments: ____________________

7.1.11 How high is sampling inlet above ground? __________

7.1.12 How high is sampling inlet above shelter? __________

7.1.13 How far is sampling probe from any structure including those on roof of shelter? ____________________

____

7.1.14 How often is instrument operation checked? __________

7.1.15 How and when is multipoint calibration done? __________

Figure A-1.
Field Systems Audit Report Form

7.1.16 What is traceability of calibration standard (i.e., what has it been checked against and when)? ______________________

7.1.17 How and when are span and precision checks made? ______________________

7.1.18 How are zero and span devices verified? ______________________

7.1.19 How and when is zero checked? ______________________

7.1.20 How often is charcoal changed and when was last change? ______________________

7.1.21 Are control charts for zero and span maintained? ______________________

7.1.22 What are control limits for adjusting span control? ______________________

7.1.23 How are span adjustments documented? ______________________

7.1.24 Dates of significant occurrences since last audit:

Calibration: ______________________

Span/Precision: ______________________

Zero: ______________________

Span adjustment: ______________________________

Zero/Span device: ______________________________

7.2 Dry deposition system

7.2.1 Manufacturer: ______________________________

7.2.2 Serial number: ______________________________

7.2.3 Are procedures that cover operation, maintenance, performance checks, and calibrations to be performed by the Site Operator available onsite? __________

7.2.4 Diagram the dry deposition sampling system:

7.2.5 Estimate length and diameter of sample line: __________
____

7.2.6 Is sample inlet clean? ______________________________

7.2.7 What is schedule for cleaning inlet and date of last cleaning? ______________________________

7.2.8 How high is sample inlet above ground? __________

7.2.9 How high is sample inlet above shelter? __________

7.2.10 How far is sample inlet from any structure, including those on roof? ____________________

____

7.2.11 Is sample elapsed time measured? ____________________

7.2.12 When are elapsed-time indicators checked? ____________________

7.2.13 What is nominal flow rate? ____________________

7.2.14 How is flow rate maintained? ____________________

7.2.15 Is flow rate recorded during sampling? ____________________

7.2.16 How is flow rate checked? ____________________

7.2.17 How often is flow rate checked? ____________________

7.2.18 Is control chart for flow rate maintained? ____________________

7.2.19 What is tolerance for flow rate? ____________________

7.2.20 When is flow rate changed? ____________________

7.2.21 How is system leak tested? ____________________

7.2.22 How often is system leak tested? ____________________

7.2.23 How often are filters changed? ____________________

7.2.24 How are filters received from the laboratory? ____________________

____

7.2.25 How are filters stored before use? ____________________
____

7.2.26 How long are filters stored before use? ______________

7.2.27 How are filters stored after use? ____________________
____

7.2.28 How long are filters stored after use? _______________

7.2.29 How are filters sent to laboratory after exposure?
____

7.2.30 What type of materials are used:

Sample inlet? ______________________________________

Sample line? ______________________________________

Filter holder? _____________________________________

Storage bags? _____________________________________

7.2.31 How often are dynamic blanks done? _________________

7.2.32 How are dynamic blanks handled? ____________________
____

7.2.33 Documentation of samples:

What forms are available for filter exposures? __________
____

What do forms contain? ____________________________
____

Where do forms go? ______________________________

____

7.3 Wet deposition system

7.3.1 Manufacturer: ______________________________

7.3.2 Serial number: ______________________________

7.3.3 Are procedures that cover operations, maintenance, performance, and calibrations to be performed by the Site Operator available onsite? ______________

7.3.4 Diagram the wet deposition sampling system:

7.3.5 How high is wet/dry sampler above ground? ______________

7.3.6 How high is wet/dry sampler above shelter? ______________

7.3.7 How often is collector operation checked? ______________

7.3.8 How is collector operation checked? ______________

____

7.3.9 How often are wet and dry liners changed? ______________

7.3.10 When are wet samples analyzed? ____________________

7.3.11 What check weights for the balance are available? ______
____

7.3.12 When is balance checked? ________________________

7.3.13 When and how are check weights checked? ____________

7.3.14 Is a control chart for check weights maintained? ______

7.3.15 What are the allowable tolerances for check weights?
____

7.3.16 What remedial action is taken if check weights are not within tolerances? ________________________
____

7.3.17 What are standards for pH and conductivity meters? ______
____

7.3.18 When and how are pH and conductivity standards checked?
____

7.3.19 When are field pH and conductivity meters calibrated?
____

7.3.20 How are consistent results obtained? ______________
____

7.3.21 Does the Site Operator wear gloves while handling samples? ______________________________

7.3.22 How are the electrodes rinsed before each use? ____________

____

7.3.23 How are the bucket liners cleaned before use? ____________

____

7.3.24 How are wet deposition aliquots prepared? ____________

____

7.3.25 How are aliquots stored before shipping to laboratory?

____

7.3.26 How long are aliquots stored before shipping to laboratory? ____________

____

7.3.27 How are aliquots shipped to laboratory? ____________

____

7.3.28 Documentation of samples:

What forms are available? ____________

____

What do forms contain? ____________

____

Where do forms go? ____________

____

7.4 Meteorological Monitoring

7.4.1 Are procedures that cover operations, maintenance, performance, and calibrations to be performed by the Site Operator available onsite? ____________

7.4.2 Diagram the location of meteorological sensors:

7.4.3 Height of sensors above ground and shelter:

Windspeed: ______

Wind direction: ______

Temperature (upper): ______

Temperature (lower): ______

Relative humidity: ______

Solar radiation: ______

Rain Gauge: ______

7.4.4. Windspeed sensor:

7.4.4.1 Manufacturer/model: ______

7.4.4.2 Serial number: ______

7.4.4.3 When and how are zero and span checks performed?

______

7.4.4.4 When and how is sensor checked for proper operation? ______

______

Figure A-1.
Field Systems Audit Report Form

7.4.4.5 What is traceability of anemometer cups? ________
____

7.4.4.6 Are spare cups available? ____________________

7.4.4.7 When and how was system calibrated? __________
____

7.4.4.8 When are bearings changed? __________________

7.4.4.9 Date of last bearing change? ________________

7.4.4.10 What other maintenance is performed, schedule of performance, and date of last performance?
____
____

7.4.5 Wind direction sensor:

7.4.5.1 Manufacturer/model: ______________________
7.4.5.2 Serial number: __________________________
7.4.5.3 When and how are zero and span checks performed?
____

7.4.5.4 When and how is sensor checked for proper operations? ____________________________________
____

7.4.5.5 Is a spare vane available? __________________

7.4.5.6 When and how was system calibrated? __________
____

7.4.5.7 When are bearings changed? __________________

7.4.5.8 Date of last bearing change? ______________

7.4.5.9 What other maintenance is performed, schedule of performance, and date of last performance?

____

____

7.4.6 Temperature:

7.4.6.1 Manufacturer/model: ______________

7.4.6.2 Serial number: ______________

7.4.6.3 When and how are zero and span checks performed?

____

7.4.6.4 When and how are sensors checked for proper operations? ______________

____

7.4.6.5 Is a calibrated thermometer available to check temperature? ______________

____

7.4.6.6 When and how are the sensors calibrated? ______

____

7.4.6.7 When and how is the aspirator motor checked?

____

7.4.6.8 Is a spare aspirator motor available? ______

____

7.4.6.9 What maintenance is performed, schedule of performance, and date of last performance? ______

____

7.4.7 Relative humidity:

7.4.7.1 Manufacturer/model: ____________________

7.4.7.2 Serial number: ____________________

7.4.7.3 When and how are zero and span checks performed?

____

7.4.7.4 When and how is the sensor checked for proper operation? ____________________

____

7.4.7.5 Is the sensor checked against a psychrometer with calibrated thermometers? ____________

7.4.7.6 How and when was the sensor calibrated? ________

____

7.4.7.7 When is bobbin recoated with lithium chloride (LiCl)? ____________________

7.4.7.8 Date of last recoating? ____________________

7.4.7.9 What other maintenance is performed, schedule of performance, and date of last performance?

____

____

7.4.8 Solar radiation:

7.4.8.1 Manufacturer/model: ____________________

7.4.8.2 Serial number: ____________________

7.4.8.3 When and how are zero and span checks performed?

____

7.4.8.4 When and how is the sensor checked for proper operation? ____________________

____

7.4.8.5 When and how was the sensor calibrated? ________

7.4.8.6 Where is sensor located relative to tower and shelter? ____________________

7.4.8.7 Can shadows fall on sensor? ____________________

7.4.8.8 Can reflected light from nearby obstacle follow the sensor? ____________________

7.4.8.9 What maintenance is performed, schedule of performance, and date of last performance?

____

7.4.9 Rain gauge

7.4.9.1 Manufacturer/model: ____________________

7.4.9.2 Serial number: ____________________

7.4.9.3 When and how are calibrations performed? ________

____

7.4.9.4 When and how is the sensor checked for proper operation? ____________________

____

7.4.9.5 What is the traceability of the tipping bucket?

____

7.4.9.6 Are spare parts available? ____________________

7.4.9.7 What maintenance is performed, schedule of performance, and date of last performance.

____

____

7.5 Data acquisition system (DAS)/strip chart:

7.5.1 Manufacturer/model: ______________________________

7.5.2 Serial number: ______________________________

7.5.3 Are procedures that cover operations, maintenance, performance, and calibrations to be performed by the Site Operator available onsite? ______________

7.5.4 When are outputs from signal conditioners to DAS checked for proper values? ______________________________

7.5.5 When and how are inputs to DAS and strip charts checked? ______________________________

7.5.6 Is a digital multimeter (DMM) available? ______________

7.5.7 When and how is the DMM checked? ______________

7.5.8 When is the conversion of voltage to engineering units checked? ______________________________

7.5.9 What is the recording medium for the DAS? ______________

7.5.10 How are recorded data checked against inputs to DAS?

____

7.5.11 How are strip chart data used; onsite instrument operations, backup recording device? ______________

____

7.5.12 What information does Site Operator record on strip chart? ______________________
____

7.5.13 Are data inputs to DAS single or double ended? ________

7.5.14 Has the site been checked for ground loops? ________

7.5.15 If individual inputs to the DAS and strip chart or control lines from the DAS are removed, do the outputs from other instruments change? ______________

7.5.16 What maintenance is performed, schedule of performance, and date of last performance? ______________

8.0 SITE OPERATOR DOCUMENTATION

8.1 How are site visits documented? ______________________
____

8.2 What is included in site visit documentation? ______________
____

8.3 Where do copies of site visit documentation go? ______________
____

8.4 If other individuals visit the site, do they provide proper documentation for what they do onsite? ______________

8.5 What documentation on instrument histories is available?
____
____

13.0 CORRECTIVE ACTION

Are plans available for correction action resulting from:

Intramural or extramural performance audits? ____________________

Systems audits? ____________________

Interlaboratory performance audits? ____________________

Internal QA/QC checks? ____________________

Are copies of corrective action procedures available? ____________

The QA Manager or QA Supervisor is to be notified in writing of the need for and results of corrective action. Cite examples: ____________________

Are corrective action request forms available to ESE personnel? ____

Who in the organization besides the QA Manager and QA Supervisor is notified of the need for or the taking of corrective action? ____________________

Describe criteria used to evaluate the efficiency of the corrective action: ____________________

Onsite recommendations for corrective action based on this laboratory systems audit: ____________________

Sample holding time: ____________________

Holding time requirement: ____________________

Was the titrant standardized? ____________________

Was the pH meter calibrated with pH 4.0 and 7.0 standards? _____

Was a method blank run? ____ ____________________

Was the method blank acceptable? ____________________

Was one NBS reference standard (potassium hydrogen phthalate) run in duplicate in this batch? ____________________

Were the QC criteria met for this sample? ____________________

Instrument response: ____________________

Manually calculate value: ____________________
____

Does this agree with reported value? ____________________

Describe acceptable test criteria applied to the sample material: ____________________
____

List lot number for material: ____________________

Were criteria met? ____________________

Does this agree with reported value? ______________________

Describe acceptance test criteria applied to the sample material: ______________________

____

List lot number for material: ______________________

Were criteria met? ______________________

12.6 Acidity

Draw a flow diagram for the overall sample analysis and data reduction process:

ID code of observable: ______________________

Type of sample: ______________________

Analysis method: ______________________

Date of analysis: ______________________

Batch number: ______________________

ID code of observable: ______________________________

Type of sample: ______________________________

Analysis method: ______________________________

Date of analysis: ______________________________

Batch number: ______________________________

Sample holding time: ______________________________

Holding time requirement: ______________________________

Were two standards that bracket the sample range run in this batch? ______________________________

Was a method blank run? ______________________________

Was the method blank acceptable? ______________________________

Was one NBS low ionic strength reference standard run in duplicate in this batch? ______________________________

Were the QC criteria met for this sample? ______________________________

Instrument response: ______________________________

Manually calculate value: ______________________________

Was one NBS low ionic strength reference standard run in duplicate in this batch? ______________________

Were the QC criteria met for this sample? ______________

Instrument response: ______________________________

Manually calculate value: __________________________

Does this agree with reported value? _________________
____

Describe acceptance test criteria applied to the sample material: ______________________________
____

List lot number for material: ______________________

Were criteria met? _______________________________

12.5 Conductivity

Draw a flow diagram for the overall sample analysis and data reduction process:

12.4 pH

Draw a flow diagram for the overall sample analysis and data reduction process:

ID code of observable: ______________________

Type of sample: ______________________

Analysis method: ______________________

Date of analysis: ______________________

Batch number: ______________________

Sample holding time: ______________________

Holding time requirement: ______________________

Were two standards that bracket the sample range run in this batch? ______________________

Was a method blank run? ______________________

Was the method blank acceptable? ______________________

Was the method blank acceptable? ________________

Was a midlevel QC standard run for every 10 samples? ________

Was it within 5 percent RPD of initial curve? ________

Was one NBS reference standard run in this batch? ________

Was a replicate and a midlevel standard from previous batch run? ________________

How was the replicate chosen? ________________
____

Were the QC criteria met for this sample? ________

Instrument response: ________________

Manually calculate value: ________________

Does this agree with reported value? ________________

Describe acceptance test criteria applied to the sample material: ________________
____

List lot number for material: ________________

Were criteria met? ________________

12.3 Atomic Absorption

Draw a flow diagram for the overall sample analysis and data reduction process:

ID code of observable: ______________________________

Type of sample: ______________________________

Analysis method: ______________________________

Date of analysis: ______________________________

Batch number: ______________________________

Sample holding time: ______________________________

Holding time requirement: ______________________________

Were five standards and a blank run? ____________________

Was r ≥0.995 and the Y-intercept 95-percent confidence limit less than the limit of quantitation? ______________

Was a method blank run? ______________________________

Was the method blank acceptable? ____________________

Was a midlevel QC standard run for every 10 samples? __________

Was it within 5 percent RPD of initial curve? ____________

Was one NBS reference standard run in this batch? __________

Was a replicate and a midlevel standard from previous batch run? ____________________________________

How was the replicate chosen? ____________________
____

Were the QC criteria met for this sample? ______________

Instrument response: ____________________________

Manually calculate value: __________________________

Does this agree with reported value? __________________

Describe acceptance test criteria applied to the sample material: ____________________________________
____
____

List lot number for material: ______________________

Were criteria met? ______________________________
____

12.2 Technicon®

Draw a flow diagram for the overall sample analysis and data reduction process:

ID code of observable: ______________________

Type of sample: ______________________

Analysis method: ______________________

Date of analysis: ______________________

Batch number: ______________________

Sample holding time: ______________________

Holding time requirement: ______________________

Were five standards and a blank run? ______________

Was r ≥0.995 and the Y-intercept 95-percent confidence limit less than the limit of quantitation? ______________

Was a method blank run? ______________________

Was r ≥0.995 and the Y-intercept 95-percent confidence limit less than the limit of quantitation? ______________________

Was a method blank run? ______________________

Was the method blank acceptable? ______________________

Was a midlevel QC standard run for every 10 samples? __________

Was it within 5 percent relative percent difference (RPD) of initial curve? ______________________

Was one NBS reference standard run in this batch? __________

Were a replicate and a midlevel standard from previous batch run? ______________________

How was the replicate chosen? ______________________
____

Were the QC criteria met for this sample? ______________

Instrument response: ______________________

Manually calculate value: ______________________

Does this agree with reported value? ______________

Describe acceptance test criteria applied to the sample material: ______________________
____

List lot number for material: ______________________
____

Were criteria met? ______________________

12.0 TRACEABILITY

12.1 Ion Chromatography

Draw a flow diagram for the overall sample analysis and data reduction process:

ID code of observable: ______________________________

Type of sample: ______________________________

Analysis method: ______________________________

Date of analysis: ______________________________

Batch number: ______________________________

Sample holding time: ______________________________

Holding time requirement: ______________________________

Condition (columns, flow, eluent): ______________________________
____

Were five standards and a blank run? ______________________________

Procedures Review

Question/Observation:

Response/Comment:

11.0 LABORATORY INSPECTION

Examination of work areas (note lack of space, disorganization, potential for contamination, and unsafe conditions).

Observation of technician's laboratory techniques and identification of potential for contamination.

Is balance area clean and functional? Are the balances cleaned and maintained?

Observation and questioning of cleaning staff to determine:

Frequency of cleaning:

Types of cleaners:

Figure B-1.
NDDN Systems Audit Questionnaire
ESE Chemistry Laboratory

Are control charts available?

What action was taken when control limits were exceeded?

How often are USEPA and DRI reference samples run?

What were results of the most recent USEPA and DRI reference samples?

How many replicate samples are run?

What control limits are set on replicates?

Are blank samples run as a zero check in the sample mode?

How are quality control data used to assess the uncertainties in the sample data?

Was the QA Plan QC for this method followed?

Spare Parts/Supplies

What spare parts and supplies are kept on hand? Quantity?

Location of spare parts and supplies:

Response/Comment: ______

10.6 Acidity

Analytical Procedures

What is the analysis time? ______

What is the instrument operation range? ______

Data Processing

How are data recorded? ______

How are data reduced to total acidity? ______

How are reported results verified? ______

Quality Control

How often is a complete calibration curve developed? ______

How many points are included in a calibration curve? What is the minimum requirement? ______

What is the calibration curve range? ______

Does the calibration curve bracket the NDDN sample concentration range? ______

How often are USEPA and DRI reference samples run? ____________

What were the results of the most recent USEPA and DRI reference samples? ____________

____

How many replicate samples are run? ____________

What control limits are set on replicates? ____________

Are blank samples run as a zero check in the sample mode? ____________

How are quality control data used to assess the uncertainties in the sample data? ____________

____

Was the QA Plan QC for this method followed? ____________

Spare Parts/Supplies

What spare parts and supplies are kept on hand? Quantity? ____________

____

____

Location of spare parts and supplies: ____________

____

Procedures Review

Question/Observation:

____

____

____

APPENDIX H

NDDN SYSTEMS AUDIT QUESTIONNAIRE
ESE CHEMISTRY LABORATORY

NDDN SYSTEMS AUDIT QUESTIONNAIRE
ESE CHEMISTRY LABORATORY

1.0 AUDIT LOCATION AND PARTICIPANTS

Date:

DRI auditor:

Location of audit:

Names and functions of persons interviewed:

2.0 ORGANIZATION

Diagram the laboratory organization and staffing for NDDN:

Figure B-1
NDDN SYSTEMS AUDIT QUESTIONNAIRE
ESE CHEMISTRY LABORATORY

U. S.
Environmental Protection Agency

National Dry Deposition Network

Responsibilities of key personnel: ______

3.0 TRAINING

What is the general awareness of the NDDN wet and dry deposition sampling plan? ______

What training procedures are used for NDDN filter preparation?

SOP No.: ______

What training procedures are used for NDDN filter handling?

SOP No.: ______

What training procedures are used for NDDN filter analysis?

SOP No.: ______

What training procedures are used for NDDN wet deposition sample handling?

SOP No.: ______

What training procedures are used for NDDN wet deposition sample analysis?

SOP No.: ______

Give a brief description of the background training of each staff member assigned to NDDN sample analyses.

____

____

____

____

____

4.0 PROCEDURES PRIOR TO ANALYSIS

Diagram the chain-of-custody protocol for NDDN samples. Is it consistent with the QA Plan? ______________________________

List responsibilities of personnel. Are they consistent with the QA Plan? ______________________________

____

____

Describe sample labeling protocol. Is it consistent with the QA Plan? ______________________________

____

____

Describe distribution of dry deposition materials to field sites. Is it consistent with the QA Plan? ____________________

Describe distribution of wet deposition materials to field sites. Is it consistent with the QA Plan? ____________________

Describe procedure for sample check-in. Is it consistent with the QA plan? ____________________

5.0 OVERVIEW OF WET DEPOSITION ANALYSIS

5.1 List the analytical methods used for analysis of NDDN samples:

pH ____________________
Conductivity ____________________
F^- ____________________
Cl^- ____________________
NO_3^- ____________________
NO_2^- ____________________
PO_4^{-3} ____________________
SO_4^{-2} ____________________
NH_4^+ ____________________
Ca^{+2} ____________________
Mg^{+2} ____________________
Na^+ ____________________
K^+ ____________________
Acidity ____________________

5.2 List references to detailed procedures. Note any modifications. ________________________________
____
____

5.3 Are SOPs available in the laboratory to all operating personnel for determination of these species? ________________________________
____

5.4 Acceptance criteria following procurement.

What acceptance criteria are applied to wet deposition material? ________________________________
____
____

How often are they applied? Is this consistent with the QA Plan? ________________________________
____

5.5 Instrumentation

List available instrumentation, including model number, for the analyses listed in 5.1. ________________________________
____
____
____
____
____

5.6 Work Area

How much space is alloted to analysis of NDDN wet deposition samples in the following areas:

Sample receiving and logging? ________________________________

Storage? ________________________________

Analytical methods? ________________________________

Data reduction? ________________________________

Is the work area organized to minimize the risk of error in sample handling and analyses? ____________________

____

5.7 Sample Handling

What type of area is used for sample processing? __________

____

How is contamination of samples avoided? ______________

____

What is the preferred order of analysis? ______________

____

What volumes are needed for each analysis? ____________

____

____

____

____

____

6.0 OVERVIEW OF DRY DEPOSITION SAMPLE ANALYSIS

6.1 List the analytical methods used for analysis of NDDN samples:

SO_4^{-2} ______________________________________

NO_3^- ______________________________________

6.2 List references to detailed procedures. Note any modifications. ______________________________

____

6.3 Are SOPs available in the laboratory to all operating personnel for determination of these species? ______________

____

6.4 Acceptance criteria following procurement

What acceptance criteria are applied to dry deposition material? ______________________________

____

____

How often are they applied? Is this consistent with the QA Plan? ______________________________

____

6.5 Instrumentation

List available instrumentation, including model number, for the analyses listed in 6.1. ______________________________

____

List operator name and title ______________________________

____

6.6 Work Area

How much space is alloted to the preparation and analysis of NDDN dry deposition samples in the following areas:

Sample receiving and logging? ______________________________

Filter preparation? ______________________________

Filter storage? ______________________________

Analytical methods? ______________________________

Data reduction? ______________________________

Is the work area organized to minimize the risk of error in sample handling and analyses? ______________________________

____

6.7 Sample Handling

What type of area is used for sample processing? ______________________________

____

How is contamination of samples avoided? ____________________

____

6.8 Filter Handling

What filter medium is used for each analyte? ________________

____

What type of area is used for filter processing? ____________

____

What techniques are used for filter impregnation? ___________

____

How is contamination of samples avoided? ____________________

____

How are filters handled? ____________________________________

____

Are filters cut? How? What portion is used for analysis?

____

____

How is the extraction performed (media, volume, containers, ultrasonic, etc.)? ____________________________

____

How many samples are included in each extraction? ___________

____

How is efficiency of extraction estimated? __________________

____

What temperature is the extract stored at? Is it checked?

____

____

7.0 WATER SUPPLY

Describe the system used to produce pure water for analytical determinations. ______________________________

____

____

List the water quality criteria. ______________________________

____

____

List the tests performed to check the water quality. ______________________________

____

____

Do test data meet the criteria? ______________________________

____

____

What action is taken when they don't? ______________________________

____

____

8.0 REAGENTS AND STOCK SOLUTIONS

What are the specifications and sources of chemicals required for the analytical determinations? ______________________________

____

____

Are chemicals dated when received and when opened? ______________________________

Do labels include: contents, concentration, date, technician's initials, and expiration date, if any? ____________________

What are stock solutions prepared from? ____________________
____

What are the concentrations of stock solutions? ____________________
____

Are mixed standards prepared (i.e., SO_4^{-2} and NO_3^-)? ____________

How are standards stored and protected from contamination?
____
____

9.0 GLASSWARE

Is glassware dedicated to the above determinations? ____________

How is glassware cleaned and stored? ____________________
____

How is contamination by absorbed NH_4^+ prevented? ____________
____

10.0 ANALYTICAL METHODS

10.1 Ion Chromatography

Analytical Procedures

List relevant SOPs: ____________________
____

What is the analysis cycle time? ____________________

What are the eluent strength, flow rate, and columns used for these analyses? ______________________________

____

What is the peak resolution for SO_4^{-2} (peak width at 1/2 height)? ______________________________

____

What is the instrument operating range or scale? ______________

____

What is the instrument lower detectable limit? How is it determined? ______________________________

____

Data Processing

How are data recorded? ______________________________

____

How are the data reduced to concentrations? ______________

____

How are reported results verified? ______________________________

____

____

Quality Control

How often is a complete calibration curve developed? ______________

How many points are included in a calibration curve? What is the minimum requirement? ______________________________

What is the calibration curve range?

____

Does the calibration curve bracket the NDDN sample concentration range? ____________________

Are control charts available? ____________________

What are control limits? ____________________

What action was taken when control limits were exceeded? ____________________
____

How often are USEPA and DRI reference samples run? ____________________
____

What were the results of the most recent USEPA and DRI reference samples? ____________________
____

How many replicate samples are run? ____________________

What control limits are set on replicates? ____________________

Are blank samples run as a check? ____________________

How are quality control data used to assess the uncertainties in the sample data? ____________________
____

Was the QA Plan QC for this method followed? ____________________

Spare Parts/Supplies

What spare parts and supplies are kept on hand? Quantity? ____________________
____

Location of spare parts and supplies. ______________________
____

Procedures Review

Question/Observation

____
____
____

Response/Comment

____
____
____

10.2 TECHNICON®

Analytical Procedures

List relevant SOPs: ______________________
____

What is the analysis time? ______________________

What is the instrument operating range? ______________________

What is the instrument lower detectable limit? How is it determined? ______________________
____

What is the filter wavelength cutoff? ______________________
____

Data Processing

How are data recorded? ______________________
____

How are the data reduced to concentrations? ____________________

How are reported results verified? ____________________

Quality Control

How often is a complete calibration curve developed? ____________________

How many points are included in a calibration curve? What is the minimum requirement? ____________________

What is the calibration curve range? ____________________

Does the calibration curve bracket the NDDN sample concentration range? ____________________

Are control charts available? ____________________

What are control limits? ____________________

What action was taken when control limits were exceeded? ____________________

How often are USEPA and DRI reference samples run? ____________________

What were the results of the most recent USEPA and DRI reference samples? ____________________

How many replicate samples are run? ____________________

What control limits are set on replicates? ____________________

Are blank samples run as a zero check in the sample mode? ________

How are quality control data used to assess the uncertainties in the sample data? ____________________

____

Was the QA Plan QC for this method followed? ____________________

Spare Parts/Supplies

What spare parts and supplies are kept on hand? Quantity? ________

____

____

Location of spare parts and supplies? ____________________

____

Procedures Review

Question/Observation:

____

____

____

Response/Comment:

____

____

____

10.3 Atomic Absorption

Analytical Procedures

List relevant SOPs: ____________________

____

What is the analysis time? ____________________

What is the instrument lower detectable limit? How is it determined? ____________________

What are the lamp wavelengths? ____________________

Data Processing

How are data recorded? ____________________

How are the data reduced to concentrations? ____________________

How are reported results verified? ____________________

Quality Control

How often is a complete calibration curve developed? ____________________

How many points are included in a calibration curve? What is the minimum requirement? ____________________

What is the calibration curve range? ____________________

Does the calibration curve bracket the NDDN sample concentration range? ____________________

Are control charts available? ____________________

What are control limits?

What action was taken when control limits were exceeded?

How often are USEPA and DRI reference samples run?

What were the results of the most recent USEPA and DRI reference samples?

How many replicate samples are run? (Another aliquot of same extract?)

What control limits are set on replicates?

Are blank samples run as a zero check in the sample mode?

How are quality control data used to assess the uncertainties in the sample data?

Was the QA Plan QC for this method followed?

Spare Parts/Supplies

What spare parts and supplies are kept on hand? Quantity?

Location of spare parts and supplies? ________________________
____

Procedures Review

Question/Observation:
____
____
____

Response/Comment:
____
____
____

10.4 pH

Analytical Procedures

List relevant SOPs: ____
____

What is the analysis time? __________________________________

What is the instrument operation range? _____________________

Data Processing

How are data recorded? ______________________________________
____

How are reported results verified? __________________________

Quality Control

How often is a complete calibration curve developed? __________

How many points are included in a calibration curve? What is the minimum requirement? ____________________

____

____

Are the sample and standard at room temperature? ____________

What is the calibration curve range? ____________________

Does the calibration curve bracket the NDDN sample concentration range? ____________________

Are control charts available? ____________________

What are control limits? ____________________

What action was taken when control limits were exceeded? ________

____

____

How often are USEPA and DRI reference samples run? ____________

What were the results of the most recent USEPA and DRI reference samples? ____________________

____

____

____

How many replicate samples are run? ____________________

What control limits are set on replicates? ____________________

Are distilled blanks run as a zero check in the sample mode? ____________________

How are quality control data used to assess the uncertainties in the sample data? ____________________

____

____

Was the QA plan QC for this method followed? ____________________

Spare Parts/Supplies

What spare parts and supplies are kept on hand? Quantity? __________

____

____

Location of spare parts and supplies. ____________________

____

Procedures Review

Question/Observation:

____

____

____

Response/Comment:

____

____

____

10.5 Conductivity

Analytical Procedures

List relevant SOPs: ____________________

____

What is the analysis time? ____________________

What is the instrument operation range? ______________________

What is the instrument lower detectable limit? How is it determined? ______________________

____

____

Data Processing

How are data recorded? ______________________

____

How are reported results verified? ______________________

____

Quality Control

How often is a complete calibration curve developed? ______________________

How many points are included in a calibration curve? What is the minimum requirement? ______________________

____

Are the sample and standard at room temperature? ______________________

What is the calibration curve range? ______________________

Does the calibration curve bracket the NDDN sample concentration range? ______________________

Are control charts available? ______________________

What are control limits? ______________________

What action was taken when control limits were exceeded? ______________________

____

APPENDIX I

MOUNTAIN CLOUD CHEMISTRY PROJECT (MCCP) SYSTEMS AUDIT QUESTIONNAIRE

3.0 GENERAL INFORMATION

MCCP Site: ______________________________ Subsites: __________________________
Site Director: ____
Laboratory location: ____
Laboratory/Site Director: ____
Laboratory/Site QA Officer: ____

Audit Conducted By: ____
Agency and Address: ____
Date of Audit: ____

Personnel Contacted During Audit: (Name, Title, Phone No.)

Reviewer Signature	Date

INSTRUCTIONS:

Most of the questions are answered by marking either the yes or no line. If a yes/no response is not possible, brief explanations can be written in the margin or on the back of the sheet. Questions which are clearly not applicable should be marked with "NA" in the left margin.

Questions with a third entry mark require that the documentation for that specific area of inquiry be presented to the auditors at the time of the audit.

Questions relating to the Lab, the Site, Data Handling and Management are referenced by the letters "L", "S", "D", and "M".

3.1. CONTINUOUS MONITORING PARAMETERS
3.1.1 OZONE MONITOR

Site: ______________________________ Date: ______________
Subsite: ____

Ozone analyzer:
- a) Manufacturer: ______________________________
- b) Model: ____________________________________
- c) Date last calibration performed: ____________
- d) Date previous calibration performed: _________
  By whom: _____________________________________

Transfer standard:
- a) Manufacturer: ______________________________
- b) Calibrator: ________________________________
- c) Serial number: _____________________________
- d) Date of last calibration: ____________________
- e) Traceable to an NBS source. If yes: __________

Primary standard (NBS source):
- a) Manufacturer: ______________________________
- b) Model: ____________________________________

		Y	N	D
1.	Does the site technician have copies of the SOP	___	___	___
2.	Has the technician been trained to operate the analyzer? Date trained: ________ By whom: ______________	___	___	
3.	Is the analyzer operated in a environmentally controlled shelter or area?	___	___	
4.	Are the operational monitor's support devices and materials kept in similar environment?	___	___	
5.	Are the following within EPA guidelines for monitoring ozone:			
	a) Zero air?	___	___	
	b) Tubing?	___	___	
	c) Manifolds?	___	___	
	d) Particulate fiters?	___	___	
	e) Ozonator?	___	___	
	f) Calibrator?	___	___	
6.	Is the monitor calibrated twice a year	___	___	
7.	Is calibration logbook maintained at field site?	___	___	___
8.	Has an accuracy audit been performed in the past year?	___	___	___
9.	Are precision measurements made 25 times a year?	___	___	___

10. Is the last precision measurement within the control limits? __ __

11. Is a zero check performed on weekly basis? __ __ __

12. Was the last zero drift calculation within the control limits? __ __ __

13. Is span check performed on weekly basis? __ __ __

14. Was the last span drift calculation within the control limits? __ __

15. Are the following data validation functions performed: (D)
    a) Final data validation at sites ? __ __ __
    b) Range testing? __ __ __
    c) Consistency checks? __ __ __
    d) Time Series Review __ __ __

16. Is preventive maintenance performed on monitor as required? __ __

17. Is the monitor's maintenance logbook kept up to date? __ __ __

18. Are corrective action procedures followed as required and necessary? __ __

19. Are field logbooks filled out in an organized manner? __ __

20. Are the QC data forms & control charts filled out in an organized manner? __ __

21. Are QC and field sheets current and available for audit review? __ __ __

22. Do data log records include: (D)
    a) Dates of data omission and cause? __ __ __
    b) Periods of questionable data and cause? __ __ __
    c) Chain-of-custody? __ __ __

23. Does the supervisor periodically validate data forms? If yes: __ __ __ (M)
    By whom:______________________Date:______________

24. Are computer validation reports & data summaries reviewed by site QA coordinator? __ __ __ (M)

25. Have the following audits been performed: (M)

a) Internal systems audit? If yes:
By whom:________________________Date:__________ ___ ___ ___

b) Internal performance audit? If yes:
By whom:________________________Date:__________ ___ ___ ___

c) External systems audit? If yes:
By whom:________________________Date:__________ ___ ___ ___

e) External performance audit? If yes:
By whom:________________________Date:__________ ___ ___ ___

26. Are internal ozone QA reports prepared on timely basis and as specified? ___ ___

3.1. CONTINUOUS MONITORING PARAMETERS
3.1.2 HYDROGEN PEROXIDE MONITOR

Site: ______________________________ Date: ________________
Subsite: ____

Monitor manufacturer and model ________________________________
Aqueous or Gas Phase? ____

		Y	N	D	
1.	Does the site technician have copies of the SOP	__	__	__	
2.	Has the technician been trained to operate the analyzer? Date trained: ________ By whom: ______________	__	__		
3.	Is the analyzer operated in a environmentally controlled shelter or area?	__	__		
4.	Are the operational monitor's support devices and materials kept in similar environment?	__	__		
5.	Is the monitor operated in accordance with the MCCP QA Plan	__	__		
6.	Is the analyzer's recorder calibrated?	__	__		
7.	Are the standard solutions prepared from analytical grade materials?	__	__		
8.	Are the calibration solutions prepared according to the MCCP protocols?	__	__		
9.	Is the monitor calibrated each day it is used?	__	__		
10.	Is calibration logbook maintained at field site?	__	__	__	
11.	Are precision measurements made on a monthly basis	__	__	__	
12.	Is the last precision measurement within the control limits	__	__		
13.	Are the following data validation functions performed:				(D)
	a) Final data validation at sites ?	__	__	__	
	b) Range testing?	__	__	__	
	c) Consistency checks?	__	__	__	
	d) Time Series Review	__	__	__	
14.	Is preventive maintenance performed on monitor as required?	__	__		

15. Is the monitor's maintenance logbook kept up to date? — — —

16. Are corrective action procedures followed as required and necessary? — —

17. Are field logbooks filled out in an organized manner? — —

18. Are the QC data forms & control charts filled out in an organized manner? — —

19. Are QC and field sheets current and available for audit review? — — —

20. Do data log records include: (D)
    a) Dates of data omission and cause? — — —
    b) Periods of questionable data and cause? — — —
    c) Chain-of-custody? — — —

21. Does the supervisor periodically validate data forms? If yes:
    By whom:____________________Date:____________ — — — (M)

22. Are computer validation reports & data summaries reviewed by site QA coordinator? — — — (M)

23. Have the following audits been performed: (M)
    a) Internal systems audit? If yes:
    By whom:____________________Date:________ — — —
    b) Internal performance audit? If yes:
    By whom:____________________Date:________ — — —
    c) External systems audit? If yes:
    By whom:____________________Date:________ — — —
    e) External performance audit? If yes:
    By whom:____________________Date:________ — — —

24. Are internal hydrogen peroxide QA reports prepared on timely basis and as specified? — —

3.1. CONTINUOUS MONITORING PARAMETERS
3.1.3 SULFUR DIOXIDE MONITOR

Site: ______________________________

Subsite: ______________________________ Date: ______________

Sulfur Dioxide analyzer:
  a) Manufacturer: ______________________________
  b) Model: ______________________________
  c) Date last calibration performed: ______________
  d) Date previous calibration performed: ______________
     By whom: ______________________________

Sulfur Dioxide Calibrator:
  a) Manufacturer: ______________________________
  b) Serial number: ______________________________

Primary standard (NBS source):
  a) Manufacturer: ______________________________
  b) Model: ______________________________

	Y	N	D
1. Does the site technician have copies of the SOP	___	___	___
2. Has the technician been trained to operate the analyzer? Date trained: ________ By whom: ______________	___	___	
3. Is the analyzer operated in a environmentally controlled shelter or area?	___	___	
4. Are the operational monitor's support devices and materials kept in similar environment?	___	___	
5. Are the following within EPA guidelines for monitoring sulfur dioxide?			
a) Zero air?	___	___	
b) Tubing (teflon or glass)	___	___	
c) Manifolds?	___	___	
d) Particulate filters?	___	___	
e) Sulfur Dioxide Gas?	___	___	
f) Permeation tubes?	___	___	
6. Is the monitor calibrated twice a year	___	___	
7. Is calibration logbook maintained at field site?	___	___	___
8. Are precision measurements made biweekly?	___	___	___
9. Is the last precision measurement within the control limits?	___	___	

10. Is a zero check performed on weekly basis? ___ ___ ___

11. Was the last zero drift calculation within the control limits? ___ ___ ___

12. Is span check performed on weekly basis? ___ ___ ___

13. Was the last span drift calculation within the control limits? ___ ___

14. Are the following data validation functions performed: (D)
    a) Final data validation at sites ? ___ ___ ___
    b) Range testing? ___ ___ ___
    c) Consistency checks? ___ ___ ___
    d) Time Series Review ___ ___ ___

15. Is preventive maintenance performed on monitor as required? ___ ___

16. Is the monitor's maintenance logbook kept up to date? ___ ___ ___

17. Are corrective action procedures followed as required and necessary? ___ ___

18. Are field logbooks filled out in an organized manner? ___ ___

19. Are the QC data forms & control charts filled out in an organized manner? ___ ___

20. Are QC and field sheets current and available for audit review? ___ ___ ___

21. Do data log records include: (D)
    a) Dates of data omission and cause? ___ ___ ___
    b) Periods of questionable data and cause ___ ___ ___
    c) Chain-of-custody? ___ ___ ___

22. Does the supervisor periodically validate data forms? If yes:
    By whom:____________________Date:______________ ___ ___ ___ (M)

23. Are computer validation reports & data summaries reviewed by site QA coordinator? ___ ___ ___ (M)

24. Have the following audits been performed:

a) Internal systems audit? If yes: (M)
By whom:____________________Date:__________ — — —

b) Internal performance audit? If yes:
By whom:____________________Date:__________ — — —

c) External systems audit? If yes:
By whom:____________________Date:__________ — — —

e) External performance audit? If yes:
By whom:____________________Date:__________ — — —

25. Are internal sulfur dioxide reports prepared on a timely basis and as specified? — —

3.1. CONTINUOUS MONITORING PARAMETERS
3.1.4 NITROGEN OXIDES (NOX) MONITOR

Site: ______________________________ Date: ______________
Subsite: ____

NOX Analyzer:
- a) Manufacturer: ____________________________________
- b) Model: ____
- c) Date last calibration performed: ______________
- d) Date previous calibration performed: __________
  By whom: ____

NOX Calibration:
- a) Manufacturer: ____________________________________
- b) Serial number: ___________________________________

NOX Standard (NBS Source):
- a) Manufacturer: ____________________________________
- b) Model: ____

		Y	N	D
1.	Does the site technician have copies of the SOP	__	__	__
2.	Has the technician been trained to operate the analyzer? Date trained: ________ By whom: ______________	__	__	
3.	Is the analyzer operated in a environmentally controlled shelter cr area?	__	__	
4.	Are the operational monitor's support devices and materials kept in similar environment?	__	__	
5.	Are the following within EPA guidelines for monitoring NOX?			
	a) Zero air?	__	__	
	b) Tubing (teflon or glass)	__	__	
	c) Manifolds?	__	__	
	d) Particulate filters?	__	__	
	e) NOX Gas	__	__	
	f) Permeation tubes?	__	__	
6.	Is the monitor calibrated twice a year	__	__	
7.	Is calibration logbook maintained at field site?	__	__	__
8.	Are precision measurements made biweekly?	__	__	__
9.	Is the last precision measurement within the control limits	__	__	

10. Is a zero check performed on weekly basis? ___ ___ ___

11. Was the last zero drift calculation within the control limits? ___ ___ ___

12. Is span check performed on weekly basis? ___ ___ ___

13. Was the last span drift calculation within the control limits? ___ ___

14. Are the following data validation functions performed: (D)
    a) Final data validation at sites ? ___ ___ ___
    b) Range testing? ___ ___ ___
    c) Consistency checks? ___ ___ ___
    d) Time Series Review ___ ___ ___

15. Is preventive maintenance performed on monitor as required? ___ ___

16. Is the monitor's maintenance logbook kept up to date? ___ ___ ___

17. Are corrective action procedures followed as required and necessary? ___ ___

18. Are field logbooks filled out in an organized manner? ___ ___

19. Are the QC data forms & control charts filled out in an organized manner? ___ ___

20. Are QC and field sheets current and available for audit review? ___ ___ ___

21. Do data log records include: (D)
    a) Dates of data omission and cause? ___ ___ ___
    b) Periods of questionable data and cause? ___ ___ ___
    c) Chain-of-custody? ___ ___ ___

22. Does the supervisor periodically validate data forms? If yes:
    By whom:________________________Date:_______________ ___ ___ ___ (M)

23. Are computer validation reports & data summaries reviewed by site QA coordinator? ___ ___ ___ (M)

24. Have the following audits been performed: (M)
a) Internal systems audit? If yes:
By whom:______________________Date:_________ __ __ __
b) Internal performance audit? If yes:
By whom:______________________Date:_________ __ __ __
c) External systems audit? If yes:
By whom:______________________Date:_________ __ __ __
e) External performance audit? If yes:
By whom:______________________Date:_________ __ __ __

25. Are internal NOX reports prepared on a timely basis and as specified? __ __

3.2 BATCH SAMPLE MONITORING PARAMETERS
3.2.1 WET DEPOSITION SAMPLE COLLECTION, ANALYSIS AND TRANSPORT (At Field Site)

Site: ______________________________
Subsite: ______________________________ Date: ______________

Which one of the following collectors is considered in this audit questionnaire (check one)?

a) Cloud Water ___
b) Rainwater ___
c) Liquid Water Content ___

(Please complete separate copies of this questionnaire for each of the above, if utilized by your Cooperative.)

Wet Deposition Collector:

a) Model/type: ______________________________
b) Manufacturer: ______________________________

Sample Collection

Y N D

1. Does the field collection site have a designated QA officer? ___ ___
   Name: ______________________________

2. Does the site technician have copy of the SOP/RPM at his/her disposal at the time of sample collection? ___ ___

3. Has the technician been trained to collect the sample? ___ ___ ___
   Date trained: __________ By whom: ______________

4. Is the sample collected in accordance with the SOP ___ ___

5. Is field site logbook maintained at the collection site? ___ ___ ___

6. Are field forms maintained at the collection site? ___ ___ ___

7. Are sample collectors, containers, etc. washed in deionized water before/after use? ___ ___

8. Are collectors stored in a dust free environment? ___ ___

9. Are cloud water and rainwater sampled at height of at least 3m above any surrounding canopy? ___ ___

10. Is unique sample ID assigned to each collected sample? If yes, is it on: ___ ___
    a) Sample collection bottle? ___ ___ ___
    b) Corresponding MCCP Wet Sample Observer's Form? ___ ___ ___
    c) Site operation logbook? ___ ___ ___

11. Are blank samples prepared? ___ ___ ___

12. Are precautions taken to keep containers and lid pairs from being switched? ___ ___

13. Are collectors, buckets, and funnels stored in a dust free environment between events? ___ ___

14. Is sample weighed and recorded at collection site? ___ ___ ___

15. Are precision measurements made at your site? ___ ___ ___

16. Is documentation, such as the site cloud event logbook, maintenance and repair logbook, etc. maintained at the field collection site to support QC activities? ___ ___ ___

17. Is routine preventive maintenance performed on the sampling devices? ___ ___

18. Is data validation performed for sample collection?
By whom:__________________ Date:____________________ ___ ___ ___ (D)

19. Are computer printouts and reports spot-checked and validated by site personnel?
By whom:______________________ Date:_____________ ___ ___ ___ (D)

20. Are field data sheets filled out in an organized manner? ___ ___ ___

21. Have any of the following audits been performed: (M)
   a) Internal systems audit? If yes:
      By whom:______________________ Date:_________ ___ ___ ___
   b) Internal performance audit? If yes:
      By whom:______________________ Date:_________ ___ ___ ___
   c) External systems audit? If yes:
      By whom:______________________ Date:_________ ___ ___ ___
   d) External performance audit? If yes:
      By whom:______________________ Date:_________ ___ ___ ___

22. Are internal QC reports prepared on timely basis and as specified? ___ ___ ___ (M)

Sample Analysis

23. If any of the following analytical instruments are used for measurements at the field site, copy and complete the appropriate section of the questionnaire for each one:
    - a) pH meter ____
    - b) Conductivity meter ____
    - c) Balance ____
    - d) Thermometer ____

Sample Transport

	Y	N	D	
24. Are blank or known samples used to ascertain the effects of sample transport?	___	___	___	
25. Are precleaned containers used for sample shipping?	___	___		
26. Are MCCP cloud water shipping forms sent along with the sample?	___	___		
27. Are MCCP cloud water field forms sent along with the sample?	___	___		
28. Is the unique sample ID copied onto:				
a) Shipping bottle?	___	___		
b) Shipping form?	___	___	___	
29. Is the sample temperature maintained below 8 degrees Celsius during shipment to lab?	___	___	___	(L)
30. Is sample temperature log sheet available for audit review?	___	___	___	(L)

3.2.2 WET DEPOSITION SAMPLE STORAGE

Site:________________________________Date:_________________

		Y	N	D
1.	Are blank or known samples used to ascertain the effects of storage?	___	___	___
2.	Are precleaned containers used for sample storage?	___	___	
3.	Are samples stored in the range of the 1-8 degree Celsius?	___	___	___
4.	Is sample temperature log sheet available for audit review?	___	___	___
5.	Is the sample stored in a manner to prevent sample contamination?	___	___	
6.	Is the storage procedure and log validated periodically by MCCP personnel? By whom:________________________Date:________________	___	___	___

3.2.3 WET DEPOSITION SAMPLE RECEIPT AND ANALYSIS
(at associated laboratory)

Site:________________________________Date:________________

Sample Receipt at Laboratory

	Y	N	D
1. Is each sample assigned a unique ID number upon receipt at the laboratory?	___	___	___
2. Does the receipt form accompany the sample?	___	___	
3. Does the field form accompany the sample?	___	___	
4. Is one of the field form copies maintained at the associated laboratory?	___	___	___
5. Are blind standards introduced into sample flow during sample receipt time?	___	___	___
6. Is logbook available for cross reference of number with date of arrival, date, and time of sample collection, etc.? If yes:	___	___	___
Is this number easily traceable to date, time, and location of sampling?	___	___	

Sample Analysis

	Y	N	D
7. Does the MCCP site-associated laboratory have:			
a) QA coordinator? Name:________________________________	___	___	
b) Lab director? Name:________________________________	___	___	
8. Are the samples analyzed for the following species/measurements:			
a) Chloride?	___	___	___
b) Nitrate?	___	___	___
c) Sulfate?	___	___	___
d) Ammonium?	___	___	___
e) Sodium?	___	___	___
f) Calcium?	___	___	___
g) Magnesium?	___	___	___
h) pH?	___	___	___

9. Are following instruments used for sample analysis? If yes, refer to appropriate section for the analytical instrument audit.
   a) pH meter? ___ ___
   b) Balance? ___ ___
   c) IC? ___ ___
   d) AA? ___ ___
   e) Thermometer? ___ ___

10. Is following documentation maintained in the lab to support quality control activities:
   a) Sample logbook? ___ ___ ___
   b) Instrument calibration logbook? ___ ___ ___
   c) Maintenance logbook? ___ ___ ___
   d) Laboratory record files? If yes: ___ ___ ___
      1) Copies of laboratory result forms generated at lab? ___ ___ ___
      2) Shipping forms received from field sites? ___ ___ ___
   e) MCCP Wet Chemical Analysis Methods Manual? ___ ___ ___
   f) MCCP QA Plan? ___ ___ ___
   g) Quality Control Charts? ___ ___ ___
   h) Recorder strip charts? ___ ___ ___

11. Is the unique MCCP ID number recorded:
   a) In sample logbook? ___ ___ ___
   b) On laboratory analytical result forms? ___ ___ ___

12. Is laboratory environment controlled? ___ ___

13. Is NBS-calibrated thermometer maintained in the lab? ___ ___ ___

14. Is accuracy determined by analysis of EPA Rain Samples ___ ___ ___

15. Are analytical precision comparisons between CAL and the associated analytical lab determined by analysis of sample splits? ___ ___ ___ (M)

16. Are one or more quality control check samples run after instrument is calibrated? ___ ___ ___

17. Are CAL supplied check samples run after every 10 to 12 samples are analyzed? ___ ___ ___

18. Are data validations performed on wet deposition analytical data? ___ ___ ___
   By whom:______________________ Date:______________

19. Are lab data sheets filled out in an organized manner? ___ ___

20. Are the QC data forms, plots, charts, etc. filled out in an organized manner? ___ ___

21. Are the QC data sheets current and available for audit review? ___ ___

22. Have any of the following audits been performed: (M)
    a) Internal systems audit? If yes:
       By whom?______________________Date:__________ ___ ___ ___
    b) Internal performance audit? If yes:
       By whom?______________________Date:__________ ___ ___ ___
    c) External systems audit? If yes:
       By whom?______________________Date:__________ ___ ___ ___
    d) External performance audit? If yes:
       By whom?______________________Date:__________ ___ ___ ___

23. Are internal wet deposition QC data reports prepared on a timely basis and as specified? ___ ___ ___ (M)

3.3 METEOROLOGICAL PARAMETERS
3.3.1 WIND SPEED MONITOR

Site:______________________________Date:_______________
Subsite:____

Wind Speed Monitor:
- a) Manufacturer:_________________Model:__________
- b) Date of last calibration:______________________
- c) Calibration by whom:___________________________

Calibrating unit:
- a) Manufacturer:_________________Model:__________

Y N D

1. Does the site technician have a copy of the SOP at his/her disposal at time of sensor operation? ___ ___

2. Has the technician been trained to operate the wind speed monitor? ___ ___
   Date trained:_____________ By whom:_______________

3. Is the wind speed sensor field site visited on a periodic basis? If yes: ___ ___
   How often?____

4. During each site visit:
   - a) Is the log sheet completed? ___ ___ ___
   - b) Is the site visit noted in the logbook? ___ ___ ___
   - c) Is a check of the freedom of rotation of the propellor made? ___ ___ ___

5. Are following calibrations performed:
   - a) "Predeployment"? ___ ___ ___
   - b) "Prestudy"? ___ ___ ___
   - c) "Prior to final removal"? ___ ___ ___
   - d) "Post study"? ___ ___ ___

6. Is calibration form completed at the time of test? ___ ___ ___
   Date of last data validation:_________________
   By whom:____

7. Are these absolute accuracy objectives used for wind speed:
   - a) 1 m/s field? ___ ___ ___
   - b) 1 m/s semi? ___ ___ ___

8. Is the wind speed monitor's sensor accuracy within MCCP Specifications ___ ___ ___

9. Are precision measurements made semi-annually? ___ ___ ___

10. Is QC check made on a monthly basis? ___ ___ ___
   a) If no, then how often:______________________________
   b) Is "Field QC check sheet" completed at the time of the check? ___ ___ ___

11. For each scheduled field QC check, are following tasks performed:
   a) Documentation on log sheet? ___ ___ ___
   b) Completion of QC check sheets? ___ ___ ___

12. Are maintenance tasks performed at each site visit? ___ ___ ___

13. Is data validation for wind speed monitor data carried out on a timely basis? ___ ___ ___ (D)

14. Does data validation process include: (D)
   a) Range testing? ___ ___ ___
   b) Consistency checks? ___ ___ ___

15. Do wind speed data records include: (D)
   a) Dates of data omission and cause? ___ ___ ___
   b) Periods of questionable data and cause? ___ ___ ___

16. Are the following printouts/reports spot-checked and validated by MCCP site or management staff: (D)
   a) Computer validation reports? ___ ___ ___
   b) Raw data reports? ___ ___ ___

17. Is periodic review of site logbooks performed to ensure that periods when instrument was not operational are flagged correctly in the final data base? ___ ___ ___ (M)

18. Are the following audits performed: (M)
   a) Internal system audits? If yes: ___ ___ ___
      By whom:____________________________Date:__________
   b) Internal performance audits? If yes: ___ ___ ___
      By whom:____________________________Date:__________
   c) External system audits? If yes: ___ ___ ___
      By whom:____________________________Date:__________
   d) External performance audits? If yes: ___ ___ ___
      By whom:____________________________Date:__________

19. Are the following sent to AWS : (M
   a) QC Check sheets? (monthly) ___ ___ ___
   b) data cassettes? (weekly) ___ ___ ___

3.3 METEOROLOGICAL PARAMETERS
3.3.2 WIND DIRECTION MONITOR

Site:______________________________Date:_______________
Subsite:____

Wind Direction Monitor
- a) Manufacturer:_________________Model:__________
- b) Date of last calibration:_______________________
- c) Calibration by whom:_____ ______________________

Calibrating unit:
- a) Manufacturer:_________________Model:__________

Y N D

1. Does the site technician have a copy of the SOP at his/her disposal at time of sensor operation? ___ ___
2. Has the technician been trained to operate the wind direction monitor? ___ ___
   Date trained:_____________ By whom:______________
3. Is the wind direction sensor visited on a periodic basis? If yes: ___ ___
   How often?____
4. During each site visit:
   - a) Is the site visit log sheet completed? ___ ___ ___
   - b) Is the site visit noted in the logbook? ___ ___ ___
   - c) Is a check of obstructions made? ___ ___ ___
   - d) Is orientation mark checked vs reference? ___ ___ ___
5. Are following calibrations performed:
   - a) "Predeployment"? ___ ___ ___
   - b) "Prestudy"? ___ ___ ___
   - c) "Prior to final removal"? ___ ___ ___
   - d) "Post study"? ___ ___ ___
6. Is calibration form completed at the time of test? ___ ___ ___
   Date of last data validation:________________
   By whom:___________________________________

7. Are precision measurements made semi-annually? ___ ___ ___

8. Is QC check made on a monthly basis?
    a) If no, then how often:____________________ ___ ___ ___
    b) Is "Field QC check sheet" completed at the time of the check? ___ ___ ___

9. For each scheduled field QC check, are following tasks performed:
    a) Documentation on log sheet? ___ ___ ___
    b) Completion of QC check sheets? ___ ___ ___

10. Are maintenance tasks performed at each site visit? ___ ___ ___

11. Is data validation for wind direction data carried out on a timely basis? ___ ___ ___ (D)

12. Does the data validation process include:
    a) Range testing? (D) ___ ___ ___
    b) Consistency checks? ___ ___ ___

13. Do wind direction data records include:
    a) Dates of data omission and cause? (D) ___ ___ ___
    b) Periods of questionable data and cause? ___ ___ ___

14. Are the following printouts/reports spot-checked and validated by MCCP site or management staff: (D)
    a) Computer validation reports? ___ ___ ___
    b) Raw data reports? ___ ___ ___

15. Is periodic review of site logbooks performed to ensure that periods when instrument was not operational are flagged correctly in the final data base? ___ ___ ___ (M)

16. Are the following audits performed:
    a) Internal system audits? If yes: (M)
        By whom:____________________Date:__________ ___ ___ ___
    b) Internal performance audits? If yes:
        By whom:____________________Date:__________ ___ ___ ___
    c) External system audits? If yes:
        By whom:____________________Date:__________ ___ ___ ___
    d) External performance audits? If yes:
        By whom:____________________Date:__________ ___ ___ ___

17. Are the following sent to AWS :
    a) QC Check sheets? (monthly) (M) ___ ___ ___
    b) data cassettes? (weekly) ___ ___ ___

3.3 METEOROLOGICAL PARAMETERS
3.3.3 TEMPERATURE SENSOR

Site:________________________________ Date:______________
Subsite:____

Temperature Sensor:
  a) Manufacturer:__________________ Model:__________
  b) Date of last calibration:______________________
  c) Calibration by whom:___________________________

Calibrating Unit:
  Manufacturer:__________________ Model:________

Y N D

1. Does the site technician have a copy of the SOP at his/her disposal at time of sensor operation? ___ ___

2. Has the technician been trained to operate the temperature sensor? ___ ___
   Date trained:____________ By whom:______________

3. Is the louvered shield mounted away from all temperature altering objects? ___ ___ ___

4. Is the temperature sensor field site visited on a periodic basis? If yes: ___ ___
   How often?____

5. During each site visit:
   a) Is the log sheet completed? ___ ___ ___
   b) Is the shield functional and level? ___ ___ ___

6. Are following calibrations performed:
   a) "Predeployment"? ___ ___ ___
   b) "Prestudy"? ___ ___ ___
   c) "Prior to final removal"? ___ ___ ___
   d) "Post study"? ___ ___ ___

7. Is the temperature sensor calibrated in conjunction with the recorder? ___ ___ ___

8. Is calibration form completed at the time of test? ___ ___ ___
   Date of last data validation:________________
   By whom:______________________________________

9. Is the temperature accuracy measurement within MCCP specifications? ___ ___ ___

10. Are precision measurements made routinely? — — —

11. Is QC check made on a monthly basis? — — —
    a) If no, then how often:____________________
    b) Is "Field QC check sheet" completed at the time of the check? — — —

12. For each scheduled field QC check, are following tasks performed:
    a) Documentation on log sheet? — — —
    b) Completion of QC check sheets? — — —

13. Are maintenance tasks performed at each site visit? — — —

14. Is data validation for temperature data carried out on a timely basis? — — — (D)

15. Does data validation process include: (D)
    a) Range testing? — — —
    b) Consistency checks? — — —

16. Do temperature data records include: (D)
    a) Dates of data omission and cause? — — —
    b) Periods of questionable data and cause? — — —

17. Are the following printouts/reports spot-checked and validated by MCCP site or management staff: (D)
    a) Computer validation reports? — — —
    b) Raw data reports? — — —

18. Is periodic review of site logbooks performed to ensure that periods when instrument was not operational are flagged correctly in the final data base? — — — (M)

19. Are the following audits performed: (M)
    a) Internal system audits? If yes: — — —
       By whom:____________________ Date:__________
    b) Internal performance audits? If yes: — — —
       By whom:____________________ Date:__________
    c) External system audits? If yes: — — —
       By whom:____________________ Date:__________
    d) External performance audits? If yes: — — —
       By whom:____________________ Date:__________

20. Are the following sent to AWS : (M
    a) QC Check sheets? (monthly) — — —
    b) data cassettes? (weekly) — — —

3.3 METEOROLOGICAL PARAMETERS
3.3.4 RELATIVE HUMIDITY (RH) SENSOR

Site:______________________________ Date:____________
Subsite:____

Relative Humidity Sensor:
- a) Manufacturer:________________ Model:__________
- b) Date of last calibration:____________________
- c) Calibration by whom:________________________

Calibrating Unit:
Manufacturer:________________Model:________

Y N D

1. Does the site technician have a copy of the SOP at his or her disposal at time of sensor operation? ___ ___
2. Has the technician been trained to operate the relative humidity sensor? ___ ___
   Date trained:____________ By whom:____________
3. Is the relative humidity sensor field site visited on a periodic basis? If yes: ___ ___
   How often?____________________________________
4. Is the louvered shield mounted away from all temperature altering objects? ___ ___
5. During each site visit:
   - a) Is the log sheet completed? ___ ___ ___
   - b) Is the shield checked for levelness? ___ ___ ___
   - c) Is the shield checked to see if fully installed? ___ ___ ___
5. Are following calibrations performed:
   - a) "Predeployment"? ___ ___ ___
   - b) "Prior to final removal"? ___ ___ ___
   - c) "Post study"? ___ ___ ___
6. Are calibration sheets completed? ___ ___ ___
   Date of last data validation:______________
   By whom:____________________________________
7. Is the temperature sensor calibrated in conjunction with the recorder? ___ ___ ___

8. Is the RH accuracy measurement within MCCP specifications? — — —

9. Are precision measurements made routinely? — — —

10. Is QC check made on a monthly basis? — — —
    a) If no, then how often:______________________
    b) Is "Field QC check sheet" completed at the time of the check? — — —

11. For each scheduled field QC check, are following tasks performed:
    a) Documentation on log sheet? — — —
    b) Completion of QC check sheets? — — —

11. Are maintenance tasks performed at each site visit? — — —

12. Is data validation for RH data carried out on a timely basis? — — — (D)

13. Does data validation process include: (D)
    a) Range testing? — — —
    b) Consistency checks? — — —

14. Do RH data records include: (D)
    a) Dates of data omission and cause? — — —
    b) Periods of questionable data and cause? — — —

15. Are the following printouts/reports spot-checked and validated by MCCP site or management staff: (D)
    a) Computer validation reports? — — —
    b) Raw data reports? — — —

17. Is periodic review of site logbooks performed to ensure that periods when instrument was not operational are flagged correctly in the final data base? — — — (M)

18. Are the following audits performed: (M
    a) Internal system audits? If yes: — — —
       By whom:______________________Date:__________
    b) Internal performance audits? If yes: — — —
       By whom:______________________Date:__________
    c) External system audits? If yes: — — —
       By whom:______________________Date:__________
    d) External performance audits? If yes: — — —
       By whom:______________________Date:__________

19. Are the following sent to AWS : (M
    a) QC Check sheets? (monthly) — — —
    b) data cassettes? (weekly) — — —

3.3 METEOROLOGICAL PARAMETERS
3.3.5 SOLAR RADIATION SENSOR (SR) SENSOR

Site: ______________________________ Date: ____________
Subsite: ____

Solar Radiation Sensor:
- a) Manufacturer: ________________ Model: __________
- b) Date of last calibration: ____________________
- c) Calibration by whom: _________________________

Calibrating Unit:
Manufacturer: _________________ Model: ________

Y N D

1. Does the site technician have a copy of the SOP at his or her disposal at time of sensor operation? ___ ___

2. Has the technician been trained to operate the solar radiation sensor? ___ ___
Date trained: ____________ By whom: _____________

3. Is the solar radiation sensor field site visited on a periodic basis? If yes: ___ ___
How often? ______________________________________

4 During each site visit:
   - a) Is the log sheet completed? ___ ___ ___
   - b) Is the sensor mounting arm secure, level, and properly oriented toward true south? ___ ___ ___
   - c) Is the sensing surface free from debris (nests, leaves, snow, ice, dirt, etc.)? ___ ___ ___

5. Are following calibrations performed:
   - a) "Predeployment"? ___ ___ ___
   - b) "Prior to final removal"? ___ ___ ___
   - c) "Post study"? ___ ___ ___

6. Are calibration sheets completed? ___ ___ ___
Date of last data validation: ________________
By whom: ____________________________________

7. Is the SR accuracy check measurement recorded on the calibration sheet? ___ ___ ___

8. Is the SR accuracy measurement within MCCP specifications? ___ ___ ___

9. Are precision measurements made routinely? ___ ___ ___

10. Is QC check made on a monthly basis? ___ ___ ___
    a) If no, then how often:______________________
    b) Is "Field QC check sheet" completed at the time of the check? ___ ___ ___

11. For each scheduled field QC check, are following tasks performed:
    a) Documentation on log sheet? ___ ___ ___
    b) Completion of QC check sheets? ___ ___ ___

11. Are maintenance tasks performed at each site visit? ___ ___ ___

12. Is data validation for SR data carried out on a timely basis? ___ ___ ___ (D)

13. Does data validation process include: (D)
    a) Range testing? ___ ___ ___
    b) Consistency checks? ___ ___ ___

14. Do SR data records include: (D)
    a) Dates of data omission and cause? ___ ___ ___
    b) Periods of questionable data and cause? ___ ___ ___

15. Are the following printouts/reports spot-checked and validated by MCCP site or management staff: (D
    a) Computer validation reports? ___ ___ ___
    b) Raw data reports? ___ ___ ___

17. Is periodic review of site logbooks performed to ensure that periods when instrument was not operational are flagged correctly in the final data base? ___ ___ ___ (M

18. Are the following audits performed: (M
    a) Internal system audits? If yes:
       By whom:____________________Date:__________ ___ ___ ___
    b) Internal performance audits? If yes:
       By whom:____________________Date:__________ ___ ___ ___
    c) External system audits? If yes:
       By whom:____________________Date:__________ ___ ___ ___
    d) External performance audits? If yes:
       By whom:____________________Date:__________ ___ ___ ___

19. Are the following sent to AWS : (M
    a) QC Check sheets? (monthly) ___ ___ ___
    b) data cassettes? (weekly) ___ ___ ___

3.3 METEOROLOGICAL PARAMETERS
3.3.6 BAROMETRIC PRESSURE (BP) SENSOR

Site:________________________________ Date:______________
Subsite:____

Barometric Pressure Sensor:
  a) Manufacturer:_________________   Model:___________
  b) Date of last calibration:_____________________
  c) Calibration by whom:__________________________

Calibrating Unit:
  Manufacturer:__________________ Model:_________

	Y	N	D
1. Does the site technician have a copy of the SOP at his or her disposal at time of sensor operation?	___	___	
2. Has the technician been trained to operate the barometric pressure sensor? Date trained:_____________ By whom:______________	___	___	
3. Is the BP sensor field site visited on a periodic basis? If yes: How often?________________________________	___	___	
4 During each site visit:			
a) Is the log sheet completed?	___	___	___
b) Is the intake nozzle checked to see if unclogged and facing down?	___	___	___
5. Are following calibrations performed:			
a) "Predeployment"?	___	___	___
b) "Prior to final removal"?	___	___	___
c) "Post study"?	___	___	___
6. Is traceability to an NBS source available for the BP data?	___	___	___
7. Are calibration sheets completed? Date of last data validation:________________ By whom:______________________________	___	___	___
8. Is the final pressure minus the reference BP less than or equal to BP accuracy (NBS reference BP value)?	___	___	___

9. Is the absolute accuracy within MCCP limits? ___ ___ ___

10. Are precision measurements made routinely? ___ ___ ___

11. Are maintenance tasks performed at each site visit? ___ ___ ___

12. Is data validation for BP data carried out on a timely basis? ___ ___ ___ (D)

13. Does data validation process include: (D)
    a) Range testing? ___ ___ ___
    b) Consistency checks? ___ ___ ___

14. Do BP data records include: (D)
    a) Dates of data omission and cause? ___ ___ ___
    b) Periods of questionable data and cause? ___ ___ ___

15. Are the following printouts/reports spot-checked and validated by MCCP site or management staff: (D)
    a) Computer validation reports? ___ ___ ___
    b) Raw data reports? ___ ___ ___

17. Is periodic review of site logbooks performed to ensure that periods when instrument was not operational are flagged correctly in the final data base? ___ ___ ___ (M)

18. Are the following audits performed: (M)
    a) Internal system audits? If yes: ___ ___ ___
       By whom:____________________ Date:__________
    b) Internal performance audits? If yes: ___ ___ ___
       By whom:____________________ Date:__________
    c) External system audits? If yes: ___ ___ ___
       By whom:____________________ Date:__________
    d) External performance audits? If yes: ___ ___ ___
       By whom:____________________ Date:__________

19. Are the following sent to AWS : (M)
    a) QC Check sheets? (monthly) ___ ___ ___
    b) data cassettes? (weekly) ___ ___ ___

3.3 METEOROLOGICAL PARAMETERS
3.3.7 PRECIPITATION SENSOR

Site:______________________ Date:__________
Subsite:______________________________

Precipitation Sensor:
- a) Manufacturer:____________ Model:________
- b) Date of last calibration:______________
- c) Calibration by whom:________________

Calibrating Unit:
Manufacturer:____________ Model:________

	Y	N	D
1. Does the site technician have a copy of the SOP at his/her disposal at time of sensor operation?	___	___	
2. Has the technician been trained to operate the precip sensor? Date trained:__________ By whom:__________	___	___	
3. Is the precip sensor field site visited on a periodic basis? If yes: How often?____________________	___	___	
4. During each site visit:			
a) Is the log sheet completed?	___	___	___
b) Is the precip gage checked for levelness?	___	___	___
c) Are the collector area & catch screen free of debris?	___	___	___
5. Are following calibrations performed:			
a) "Predeployment"?	___	___	___
b) "Prestudy"?	___	___	___
c) "Prior to final removal"?	___	___	___
d) "Post study"?	___	___	___
6. Are calibration sheets completed? Date of last data validation:__________ By whom:____________________	___	___	___
7. Is the precip sensor accuracy measurement within MCCP specifications?	___	___	___

8. Are precision measurements made routinely? ___ ___ ___

9. Is QC check made on a monthly basis? ___ ___ ___
    a) If no, then how often:______________________
    b) Is "Field QC check sheet" completed at the time of the check? ___ ___ ___

10. For each scheduled field QC check, are following tasks performed:
    a) Documentation on log sheet? ___ ___ ___
    b) Completion of QC check sheets? ___ ___ ___

11. Are maintenance tasks performed at each site visit? ___ ___ ___

12. Is data validation for precip data carried out on a timely basis? ___ ___ ___ (D)

13. Does data validation process include: (D)
    a) Range testing? ___ ___ ___
    b) Consistency checks? ___ ___ ___

14. Do precip data records include: (D)
    a) Dates of data omission and cause? ___ ___ ___
    b) Periods of questionable data and cause? ___ ___ ___

15. Are the following printouts/reports spot-checked and validated by MCCP site or management staff: (D
    a) Computer validation reports? ___ ___ ___
    b) Raw data reports? ___ ___ ___

17. Is periodic review of site logbooks performed to ensure that periods when instrument was not operational are flagged correctly in the final data base? ___ ___ ___ (M

18. Are the following audits performed: (M
    a) Internal system audits? If yes: ___ ___ ___
        By whom:______________________Date:__________
    b) Internal performance audits? If yes: ___ ___ ___
        By whom:______________________Date:__________
    c) External system audits? If yes: ___ ___ ___
        By whom:______________________Date:__________
    d) External performance audits? If yes: ___ ___ ___
        By whom:______________________Date:__________

19. Are the following sent to AWS : (M
    a) QC Check sheets? (monthly) ___ ___ ___
    b) data cassettes? (weekly) ___ ___ ___

3.4 ANALYTICAL AND SUPPORT INSTRUMENTS

3.4.1 ANALYTICAL BALANCE

Site:________________________________Date:________________
Subsite:____

Manufacturer:____
Model:____

	Y	N	D
1. Does the site technician have a copy of the SOP at his or her disposal at the time of weighing?	___	___	
2. Is the balance operated within manufacturer's range and criteria?	___	___	
3. Has the technician been trained to use the analytical balance? Date trained:________By whom:________________	___	___	___
4. Is the analytical balance placed in a shelter or area environmentally controlled for:			
a) Temperature?	___	___	___
b) Vibration?	___	___	
c) Air current?	___	___	
5. Is the balance covered with a plastic cover when not in use?	___	___	
6. Is the balance allowed to stabilize before usage?	___	___	
7. For small weight differences (<1 mg), is balance protected from air currents or enclosed in a case equipped with a door?	___	___	
8. Are objects to be weighed handled with either tongs or finger pads, etc. to prevent biased weighing?	___	___	
9. Are samples, standards, and glassware weighed:			
a) In similar environment?	___	___	
b) At room temperature?	___	___	
10. Is the material to be weighed equilibrated for temperature and humidity prior to weighing?	___	___	
11. Are the following masses recorded on the data forms and lab notebooks?			
a) Tare	___	___	___
b) Sample	___	___	___
c) Gross	___	___	___
12. Is the balance calibrated periodically? Last date of calibration:__________________	___	___	___

13. Are the weights used for calibrating the balance:
    a) NBS traceable? ___ ___ ___
    b) NBS source? ___ ___ ___

14. Is the balance calibration logbook:
    a) Kept up-to-date? ___ ___ ___
    b) Maintained at balance site (i.e., at field/lab site)? ___ ___ ___

15. Is precision measurement:
    a) Made periodically? ___ ___ ___
       Date of last precision measurement:__________
    b) Within specification/limit? ___ ___ ___

16. Is the analytical balance's preventive maintenance performed as required? ___ ___ ___

17. Is the balance's performance/maintenance logbook kept up-to-date? ___ ___ ___

18. Are corrective action procedures followed as required and necessary? ___ ___

19. Is routine factory service scheduled and implemented? ___ ___ ___
       Date of last factory service:______________

20. Is control chart used to assess balance's performance? ___ ___ ___

21. Have any of the following audits been performed: (M)
    a) Internal systems audit? If yes: ___ ___ ___
       By whom:______________________Date:__________
    b) Internal performance audit? If yes: ___ ___ ___
       By whom:______________________Date:__________
    c) External systems audit? If yes: ___ ___ ___
       By whom:______________________Date:__________
    e) External performance audit? If yes: ___ ___ ___
       By whom:______________________Date:__________

3.4.2 pH METER

Site:______________________________ Date:______________
Subsite:____

Manufacturer:____
Model:____

	Y	N	D	
1. Does the site technician have a copy of the SOP at his or her disposal near the meter at the time of analysis?	___	___		
2. Has the technician been trained to operate the meter? Date trained:________By whom:______________	___	___		
3. Is meter placed in an environmentally controlled shelter or area?	___	___		
4. Is the meter operated within the manufacturer's range and criteria?	___	___	___	
5. Does each sample submitted for pH measurement bear a unique identifying number?	___	___	___	,
6. Is the meter calibration checked at regular intervals?	___	___	___	
7. Is a calibration logbook maintained at field site/lab?	___	___	___	
8. Are sample aliquots adequate to ensure valid results?	___	___	___	
9 . Are samples and standards read in same environment?	___	___		
10. Is the pH electrode rinsed with standard, deionized water, or sample, before measurement?	___	___		
11. Is the pH electrode rinsed with deionized water between readings?	___	___		
12. Are samples analyzed in duplicates?	___	___	___	
13. Are audit samples analyzed periodically?	___	___	___	(L
14. Are the following control samples analyzed:				
a) Distilled water blanks?	___	___	___	(L
b) Old samples?	___	___	___	(L
c) QC samples?	___	___	___	

15. Are the following stored according to specification: (L)
    a) Samples? __ __
    b) Standard? __ __
    c) Other solutions? __ __

16. Are samples, standards, etc., dated for: (L)
    a) Date of receipt/opening? __ __
    b) Shelf-life? __ __

17. Is meter's preventive maintenance performed as required? __ __

18. Is the meter's maintenance logbook kept up to date? __ __ __

19. Are corrective action procedures implemented as required and necessary? __ __

20. Are all samples, standards, and solutions properly labeled? __ __

21. Is a control chart used for meter's performance? __ __

22. Are QC data forms, plots, charts, etc. filled out in an organized manner? __ __

23. Are QC sheets current and available for audit review? __ __ __

24. Do log records include:
    a) Dates of data omission and cause? __ __ __
    b) Periods of questionable data and cause? __ __ __

25. Are computer printouts and reports spotchecked and validated by MCCP site/lab staff? (D) __ __ __

26. Have any of the following audits been performed: (M)
    a) Internal systems audit? If yes:
       By whom:________________________Date:__________ __ __ __
    b) Internal performance audit? If yes:
       By whom:________________________Date:__________ __ __ __
    c) External systems audit? If yes:
       By whom:________________________Date:__________ __ __ __
    e) External performance audit? If yes:
       By whom:________________________Date:__________ __ __ __

27. Are internal QC reports prepared on timely basis and as specified? (M __ __

3.4.3 CONDUCTIVITY METER

Site:________________________________ Date:________________
Subsite:____

Manufacturer:____
Model:____

	Y	N	D	
1. Does the technician have copy of the SOP at his or her disposal near the meter at time of analysis?	___	___		(S)
2. Has the technician been trained to operate the meter? Date trained:________ By whom:________________	___	___		(S)
3. Is meter placed in an environmentally controlled shelter or area?	___	___		(S)
4. Is the meter operated within the manufacturer's range and criteria?	___	___	___	(S)
5. Is the meter calibration checked at regular intervals?	___	___	___	(S)
6. Is a calibration logbook maintained at field site/lab?	___	___	___	(S)
7. Are sample aliquots adequate to ensure valid results?	___	___	___	(S)
8. Are samples and standards read in same environment?	___	___		(S)
9. Is the cell rinsed with sample, standard, etc. before measurement?	___	___		
10. Is the cell rinsed with deionized water between readings?	___	___		
11. Are audit samples analyzed periodically?	___	___	___	
12. Are following stored according to specifications:				
a) Samples?	___	___		
b) Standard?	___	___		
c) Other solutions?	___	___		
13. Are samples, standards, etc., dated for:				
a) Date of receipt/opening?	___	___		
b) Shelf-life?	___	___		
14. Is meter's preventive maintenance performed as required?	___	___		

15. Is the meter's maintenance logbook kept up to date? ___ ___ ___

16. Are corrective action procedures followed as required and necessary? ___ ___

17. Are all samples, standards, and solutions properly labeled? ___ ___

18. Is control chart used for:
  a) Meter's performance? ___ ___ ___
  b) Species analyzed? ___ ___ ___

19. Are QC data forms, plots, charts, etc. filled out in an organized manner? ___ ___

20. Are QC sheets current and available for audit review? ___ ___ ___

21. Do data records include:
  a) Dates of data omission and cause? (D) ___ ___ ___
  b) Periods of questionable data and cause? ___ ___ ___
  c) Chain-of-custody? ___ ___ ___

22. Are computer printouts and reports spot-checked and validated by MCCP site/lab staff? (D) ___ ___ ___

23. Have any of the following audits been performed: (M)
  a) Internal systems audit? If yes: ___ ___ ___
  By whom:__________________________Date:__________
  b) Internal performance audit? If yes: ___ ___ ___
  By whom:__________________________Date:__________
  c) External systems audit? If yes: ___ ___ ___
  By whom:__________________________Date:__________
  e) External performance audit? If yes: ___ ___ ___
  By whom:__________________________Date:__________

24. Are internal QC reports prepared on timely basis and as specified? ___ ___ ___

3.4.4 ION CHROMATOGRAPH (IC)

Site:______________________________ Date:_______________
Subsite:____

Manufacturer:____
Model:____

		Y	N	D
1.	Does the site technician have a copy of the SOP at his/her disposal, near the instrument, at time of analysis?	___	___	
2.	Is the ion chromatograph operated within:			
	a) Manufacturer's range and criteria?	___	___	___
	b) MCCP's range and criteria?	___	___	___
3.	Has the technician been trained to operate the IC? Date trained:___________ By whom:_______________	___	___	
4.	Are samples, standards, etc., dated for:			
	a) Date of receipt/opening?	___	___	
	b) Shelf-life?	___	___	
5.	Is the IC operated in an environmentally controlled laboratory?	___	___	
6.	Is the IC inlet port rinsed with deionized water or a blank solution between readings?	___	___	
7.	Are following stored according to specification:			
	a) Samples?	___	___	
	b) Standard?	___	___	
	c) Other solutions?	___	___	
8.	Are samples and standards read in the same environment?	___	___	
9.	Does each sample submitted for IC analysis bear a unique identifying number?	___	___	___
10.	Is each sample aliquot adequate to ensure valid result?	___	___	___
11.	Is the IC allowed to stabilize for 2-4 hours before analysis?	___	___	

12. How often is the IC calibrated when analyses are being performed?___________________

13. Are calibration curves prepared for all species at the beginning of analysis? ___ ___

14. Are check samples run every 10th to 12th run to verify IC's proper operation? ___ ___ ___

15. Is a calibration logbook maintained at field site/lab? ___ ___ ___

16. Are standards reanalyzed periodically throughout the day? If yes:
    How often?____________________________________
    How many?____________________________________ ___ ___ ___

17. Are standards analyzed:
    a) At the beginning of the run? ___ ___ ___
    b) At the end of the run? ___ ___ ___

18. Are duplicate samples analyzed? ___ ___ ___

19. Are blinds analyzed regularly? ___ ___ ___

20. Are audit samples analyzed periodically? ___ ___ ___

21. Are calculations/statistics (i.e., concentration, slope, correlation coefficient, etc.):
    a) Calculated immediately? ___ ___
    b) Compared to previous data? ___ ___

22. Is the IC's maintenance logbook kept up to date? ___ ___ ___

23. Is IC's preventive maintenance performed as required? ___ ___

24. Are corrective action procedures implemented as required and necessary? ___ ___

25. Are all samples, standards, and solutions properly labeled? ___ ___

26. Are control charts used for:
    a) Precision measurements ___ ___ ___
    b) Species analyzed? ___ ___ ___

27. Are QC data forms, plots, charts, etc. filled out in an organized manner? ___ ___

28. Are QC sheets current and available for audit review? ___ ___ ___

29. Do data records include: D
  a) Dates of data omission and cause? ___ ___ ___
  b) Periods of questionable data and cause? ___ ___ ___

30. Are computer printouts and reports spot-checked and validated by MCCP site/lab staff? D
___ ___ ___

31. Have any of the following audits been performed: M
  a) Internal systems audit? If yes:
     By whom?________________________Date:__________ ___ ___ ___
  b) Internal performance audit? If yes:
     By whom:________________________Date:__________ ___ ___ ___
  c) External systems audit? If yes:
     By whom:________________________Date:__________ ___ ___ ___
  e) External performance audit? If yes:
     By whom:________________________Date:__________ ___ ___ ___

32. Are internal QC reports prepared on timely basis and as specified? M
___ ___

3.4.5 ATOMIC ABSORPTION SPECTROPHOTOMETER (AA)

Site:______________________________Date:_______________
Subsite:____

Manufacturer:_______________________________________
Model:____

Y N D

1. Does the site technician have a copy of the SOP at his/her disposal, near the instrument, at time of analysis? ___ ___

2. Is the AA instrument operated within:
   a) Manufacturer's range and criteria? ___ ___ ___
   b) MCCP's range and criteria? ___ ___ ___

3. Has the technician been trained to operate the AA? ___ ___
   Date trained:__________By whom:________________

4. Are samples, standards, etc., dated for:
   a) Date of receipt/opening? ___ ___
   b) Shelf-life? ___ ___

5. Is the AA operated in an environmentally controlled laboratory? ___ ___

6. Is the AA inlet port rinsed with deionized water or a blank solution between readings? ___ ___

7. Are the following prepared and shelf-life specified according to SOP's?:
   a) Stock standard/primary standard? ___ ___
   b) Dilute standard? ___ ___ ___

8. Are following stored according to specification:
   a) Samples? ___ ___
   b) Standard? ___ ___
   c) Other solutions? ___ ___

9. Is the AA allowed to warm up for at least 15 min with the flame on before the final wavelength adjustment is made? ___ ___

10. Are samples and standards read in the same environment? ___ ___

11. Does each sample submitted for AA analysis bear a unique identifying number? ___ ___ ___

12. Is each sample aliquot adequate to ensure valid result? ___ ___ ___

13. How often is the AA calibrated when analyses are being performed?____________________

14. Are calibration curves prepared for all species at the beginning of analysis? ___ ___

15. Are check samples run every 10th to 12th run to verify AA's proper operation? ___ ___ ___

16. Is a calibration logbook maintained at field site/lab? ___ ___ ___

17. Are standards reanalyzed periodically throughout the day? If yes: ___ ___ ___
    How often?____
    How many?____

18. Are standards analyzed:
    a) At the beginning of the run? ___ ___ ___
    b) At the end of the run? ___ ___ ___

19. Are duplicate samples analyzed? ___ ___ ___

20. Are blinds analyzed regularly? ___ ___ ___

21. Are audit samples analyzed periodically? ___ ___ ___

22. Are calculations/statistics (i.e., concentration, slope, correlation coefficient, etc.):
    a) Calculated immediately? ___ ___
    b) Compared to previous data? ___ ___

23. Are performance checks performed on a routine basis? ___ ___ ___

24. Is the AA's maintenance logbook kept up to date? ___ ___ ___

25. Is AA's preventive maintenance performed as required? ___ ___

26. Are corrective action procedures implemented as required and necessary? ___ ___

27. Are all samples, standards, and solutions properly labeled? ___ ___

28. Are control charts used for:
    a) Precision measurements ___ ___ ___
    b) Species analyzed? ___ ___ ___

29. If control charts are used, are they updated regularly? ___ ___ ___

30. Are QC data forms, plots, charts, etc. filled out in an organized manner? ___ ___

31. Are QC sheets current and available for audit review? ___ ___ ___

32. Do data records include: D
    a) Dates of data omission and cause? ___ ___ ___
    b) Periods of questionable data and cause? ___ ___ ___

33. Are computer printouts and reports spot-checked and validated by MCCP site/lab staff? ___ ___ ___ D

34. Have any of the following audits been performed: M
    a) Internal systems audit? If yes: ___ ___ ___
       By whom?________________________Date:__________
    b) Internal performance audit? If yes: ___ ___ ___
       By whom:________________________Date:__________
    c) External systems audit? If yes: ___ ___ ___
       By whom:________________________Date:__________
    e) External performance audit? If yes: ___ ___ ___
       By whom:________________________Date:__________

35. Are internal QC reports prepared on timely basis and as specified? ___ ___ M

3.4.6 SUPPORT INSTRUMENTS

Site:________________________________
Subsite:________________________________Date:________________
____

Thermometer
Name or ID number:________________________________ Y N D
1. Are thermometers calibrated periodically? — —
How often:________________________________
Date of last calibration:________________
By whom:________________________________
____

2. Is thermometer calibration traceable to an NBS source? — — —

Barometer
Name or ID number:________________________________
1. Are barometers calibrated periodically? — —
How often:________________________________
Date of last calibration:________________
By whom:________________________________
____

2. Are barometer calibrations traceable to an NBS source? — — —

Flowmeter
Name or ID number:________________________________
1. Are flowmeters calibrated periodically? — —
How often:________________________________
Date of last calibration:________________
By whom:________________________________
____

2. Are flowmeter calibrations traceable to an NBS source? — — —

3. Is flow meter calibrated to + 2% (EPA) accuracy, against a reliable standard? — — —

3.4.7 STRIP CHART RECORDER

Site:______________________________ Date:________________
Subsite:____

Manufacturer:____
Model:____

	Y	N	D
1. Does the operator check the recorder during each site visit for:			
a) Ink trace visibility?	__	__	
b) Ink level in reservoir?	__	__	
c) Chart paper supply?	__	__	
d) Chart paper speed setting?	__	__	
e) Signal input range switch setting?	__	__	
f) Time synchronization?	__	__	
2. Are the following recorded on the trace:			
a) Zero trace	__	__	__
b) Span trace	__	__	__
c) Calibration Point trace	__	__	__
3. Is control chart kept for the strip chart recorder's performance?	__	__	__
4. Is strip chart recorder calibrated for a zero and span of its associated instrument?	__	__	__
5. Are records or logs maintained to keep:			
a) Strip chart readings?	__	__	__
b) Strip chart calculations?	__	__	__
c) Strip information, such as calibration curves, slope, and intercept?	__	__	__
6. Does supervisor or head technician validate strip chart recorder results?	__	__	__
7. Is maintenance check performed on the strip chart recorder?	__	__	
8. Is corrective action taken for the strip chart recorder when operational limits are not within stated limits?	__	__	

3.4.8 DATA LOGGER

*Site:*______________________________ *Date:*______________
*Subsite:*____
____
*Manufacturer:*____
*Model:*____
____

1. Is data logger calibrated at: *Y N D*
   a) Predeployment? ___ ___ ___
   b) Post study? ___ ___ ___

2. Is routine maintenance performed? ___ ___ ___

3. Is calibration form completed :
   by whom: ______________________________
   date: ________________

4. Is unique, numbered cassette tape used each time for data collection in data logger? ___ ___ ___

5. At each visit, are the following site technician's procedures followed:
   a) Check of data logger time? ___ ___
   b) Removal of "current tape"? ___ ___
   c) Replacement of second tape of set? ___ ___
   d) Noting all switches on appropriate logsheets? ___ ___
   e) Leaving data logger in *0 mode? ___ ___
   f) Leaving cassette recorder in record/play mode? ___ ___
   g) Bringing the cassette tape, which has been removed, to site PC? ___ ___
   h) Dumping (downloading) data to the PC? ___ ___ (D)
   i) Performing data validation routines? ___ ___ (D)
   j) Preparing PC for VAX telecommunications? ___ ___ ___ (D)
   k) Reviewing data validation report? ___ ___ (D)

3.5.1 DATA MANAGEMENT AT FIELD SITES

(S)

Site:______________________________ Date:_______________

Y N D

1. Are all required forms kept and updated on timely basis? ___ ___

2. Are the forms filled out in a centrally located area? If yes: ___ ___
   a) Are they easily retrievable? ___ ___

3. Are cloud sampling data recorded on multi-part forms? ___ ___ ___
   a) Is one copy kept at the field site? ___ ___ ___
   b) Is one copy sent to the analyical laboratory? ___ ___ ___
   c) Is one copy maintained by the Site Director? ___ ___ ___

4. Are forms/data periodically reviewed by field site personnel? ___ ___ ___

5. Do the field site personnel validate the data processing report for certification of data? ___ ___ ___

6. Are following forms maintained:
   a) Wet sample observers form? ___ ___ ___
   b) Shipping form? ___ ___ ___
   c) Sample receipt form? ___ ___ ___
   d) Site analytical result form? ___ ___ ___

7. Are following forms filled out at site for meteorological data and sent to AWS each month:
   a) Log sheet at each site visit? ___ ___ ___
   b) Scheduled field calibration checks:
      1) Logsheets? ___ ___ ___
      2) QCcheck sheets? ___ ___ ___

Data Logger to Cassette Recorder

8. Is the tape counter set to 000 each time a new cassette is loaded? ___ ___

9. Is the volume thumbwheel of the recorder set to the level 5 to ensure proper data transfer? ___ ___

Manual Data Transfer to Tape - for sites that do not use an automatic data gathering scheme.

10. After site inspection is the met data that has accumulated since the previous site visit transferred from the 21XL data logger to cassette tape? ___ ___

11. Are following values noted on the log sheet:
  a) Current position?
  b) Final data point?
  c) Tape pointer after data transfer?
  d) Position of the final data point?

12. Is transfer of data verified by "beep-noise-beep" sequence emitted by the recorder?

Data Retrieval for Automatic Data Dumping Sites

13. At end of site visit is the 21XL checked? If yes:
  a) Are following logged in logbook:
    1) Tape pointer for *8, then A⁻sequence?
    2) Final data point position?
    3) "New tape pointer position"?
    4) Time of tape removal?
  b) Is the date of cassette removal logged into individual monthly tape log sheet?
  c) Has the tape to be inserted previously been advanced for about 4 seconds from the end of the last data recording?
  d) Are following checks made:
    1) Recorder connection?
    2) Thumbwheel setting?

14. At the beginning of month, are two new tapes used for data transfer sequence?

15. Is the removed tape transferred to the PC?

16. Is the data transferred to a file?

Transfer Cassette Tape to a Personal Computer

17. Are following forms completed: (D)
  a) Master data file log sheet A?
  b) Master data file log sheet B?

3.5.2 GENERAL DOCUMENTATION

(M)

Site:____________________________ Date:______________

Organizational Documentation

		Y	N	D
1.	Has the organization written and implemented an QA Project Plan for MCCP? Implementation Date:________________________			
2.	Has a change or modification procedure been incorporated into the documentation policy?			
3.	Are the following documents reviewed by the supervisors to determine if the documents are up-to-date:			
a)	MCCP SOPs?			
b)	MCCP QA Plan?			
c)	MCCP QA Project Plans?			
d)	In-house SOPs/RPMs?			
e)	In-house sampling and analysis logs?			
f)	QC charts and/or forms?			
g)	QC reports?			
h)	Internal and/or external audits?			
i)	Procurement logs for materials?			
j)	Traceability to standards?			
K)	Calibrations?			
l)	Internal controls (i.e., blinds, spikes, etc.)?			
4.	Are all site ancillary data submitted to for inclusion in the MCCP database			

Calibration Logbooks/Notebook/Forms

		Y	N	D
5.	Are following logbooks maintained:			
a)	Calibration/Standardization Where located:________________________ By Whom:____________________________			
b)	Maintenance? Where located:________________________ By Whom:____________________________			
6.	Are there logbooks for the following parameters/ instruments:			
a)	Ozone monitor?			
b)	Hydrogen peroxide monitor?			
c)	Cloudwater measurement?			
d)	pH meter?			
e)	Conductivity meter?			
f)	IC?			
g)	Balance?			
h)	AA?			

7. Are QC documents routinely reviewed or audited for the following:
   a) The QC data itself? ___ ___ ___
   b) Configuration control and date? ___ ___ ___
   c) Screened for QC limits? ___ ___ ___
   d) Reports of missing samples/data? ___ ___ ___

8. Are internal or external audit findings reviewed by:
   a) Analyst or technician? ___ ___ ___
   b) QC chemist? ___ ___ ___
   c) Supervisor? ___ ___ ___
   d) Principal Investigator? ___ ___ ___

9. Are audit findings and documentation of corrective actions kept by:
   a) Analyst or technician? ___ ___ ___
   b) QC chemist? ___ ___ ___
   c) Supervisor? ___ ___ ___
   d) Principal Investigator? ___ ___ ___

10. Are QC documents available for audit review? ___ ___ ___

3.5.3 GLASSWARE AND REAGENTS

(S&L)

Site:______________________________Date:_______________

Y N D

1. Are all glassware rinsed in deionized water before use?

2. Are only ACS chemicals used for calibration and preparation of primary stock standard?

3. Are either class A or calibrated volumetric glassware used for:
   a) Preparing primary stock standards?
   b) Calibrations?

4. Is deionized water tested in the laboratory?

5. Are opened reagent bottles labeled for:
   a) Date opened?
   b) Expiration date?
   c) Name of analyst opening it?

6. Are chemicals removed and disposed of when their shelf life expires?

3.5.4 CONTROL CHARTS (MIXED)

Site:________________________________ Date:________________

Instrument/Monitor/Parameter:__________________________

Manufacturer/Model:____________________________________

Y N D

1. Are data analyzed for outliers before constructing control chart? ___ ___

2. How are control limits determined?________________________

   ____

3. How often are control limits recalculated?________________

4. Are control charts interpreted for trends, cycles, assignable causes, etc.? ___ ___ ___

5. Are QC charts observed for:
   - a) Bias indicated by seven successive points on either side of center line? ___ ___
   - b) Error indicated by one point outside either limit? ___ ___
   - c) Error indicated by two values within 1% of either limit? ___ ___

6. Are out-of control limits (both upper and lower) investigated? ___ ___ ___

7. Are corrective actions taken after the investigation? ___ ___ ___

8. Does QC chemist update control chart limits and obtain new control chart on a timely basis? ___ ___

   Date of last QC chart update:________________

   By whom:________________________________

9. Does the Site Director/supervisor, routinely validate control charts and their limits? ___ ___ ___

3.5.5 STANDARDIZATION AND QUALITY CONTROL FOR LAB ANALYTICAL DATA (L)

Site:______________________________Date:_______________

Y N D

1. Is there a written procedure for calibration standards preparation? __ __
   If yes, does it include:
   a) Reagent purity? __ __
   b) Reagent storage? __ __
   c) Reagent handling? __ __
   d) Reagent labeling? __ __
   e) Reagent glassware type? __ __
2. Are reagents used in preparation of standards traceable to ACS standard source? __ __
3. Is glassware used to prepare standards and dilute samples the type recommended? __ __
4. Are only calibrated burets and pipets or class A glassware used for primary stock standard preparation? __ __
5. Are stock standards freshly prepared when required? __ __
6. Is standardization logbook maintained? If yes: __ __
   a) Is it updated periodically? __ __ __
   b) Does it include:
      1) Preparation method? __ __ __
      2) Calculations? __ __ __
      3) Date of preparation? __ __ __
      4) Concentration? __ __ __
      5) Analyst's signature/initial? __ __ __
7. Are standard calibration curves prepared for each parameter on timely basis? __ __ __
9. Are standards analyzed:
   a) At beginning of run? __ __ __
   b) At end of run? __ __ __
10. Are results of 9 (a) and 9 (b) examined for comparability to within 10%? __ __ __
11. If successive standard runs do not compare are affected samples reanalyzed? __ __ __
12. Do blanks include water from soak solution of collection apparatus? __ __ __

13. Are blind samples analyzed periodically? ___ ___ ___

14. Does the QA chemist prepare check samples
for field sites? ___ ___ ___

15. Are standard and QC data validated periodically? ___ ___ ___
If yes:
By whom:______________________Date:______________

APPENDIX J

NADP/NTN SYSTEMS AND PERFORMANCE SURVEY QUESTIONNAIRE

SYSTEMS AND PERFORMANCE SURVEY QUESTIONNAIRE: FIELD

Site Characteristics

Identification.

101 Site name ______________________ ID # ________

102 Site supervisor ______________________

103 Site operator ______________________

104 Other site operators ______________________

105 Telephone ______________________

106 Mailing address ______________________
____

107 Shipping address ______________________
____
____

108 Date of site audit visit ____________

109 Time of site audit visit ____________

Weather condition during time of site visit

110 Sky (circle one) clear overcast cloudy ______

111 Wind (circle one) calm gusty sustained wind ______

112 Precipitation (circle one) none fog mist rain sleet snow ______

113 RTI auditor's signature ______________________

114 Is this an NADP site? ________ An NTN site? ________

115 Has site operator or supervisor attended CAL course? ______

116 How long has operator been site operator? ____________

Logistics.

		Yes	No
	Is the site accessible		
117	in summer?	___	___
118	in winter?	___	___

119 How far from the nearest road is the precipitation collector? ________ (m)

120 Type of road surface? ____________

121 How close to the collector does the operator park his vehicle? ________ (m)

Topography and Land Use.

Explain all yes answers in comments at the end of this section and draw brief sketch of site.

Within 30-m

		Yes	No
122	Is the slope greater than 15 degrees?		
123	Is the ground cover other than natural vegetation and/or more than 2 feet high?		
124	Are there plowed fields or tilled areas?		
125	Is there equipment present other than the specified rain gauge and collector?		
126	Are there grazing animals?		
127	Are there any objects (solar panel, rain gauge, etc.) close to the collector or rain gauge which might deflect the wind? Describe on sketch.		

Within 100-m

		Yes	No
128	Are there any objects (trees, overhead wires, etc.) which project on the collector or rain gauge with an angle greater than 45° from horizontal?		
129	Are there storage facilities for chemicals, vehicles, etc.?		
130	Are there sources of frequent ground, water, or air traffic?		

Within 500-m to 50-km (i.e., within 30 miles)

		Yes	No
131	Are there large concentrations of animals such as feedlots, dairy barns, kennels, etc. within 500-m? (1600 feet)		

		Yes	No
132	Are there industrial operations such as factories, chemical plants, sewage treatment plants, etc. within 10-km? (6 miles)	___	___
133	Are there up-wind industrial operations within 20-km? (12 miles)	___	___
134	Are there suburban or urban areas containing more than 10,000 people within 10-km? (6 miles)	___	___
135	Are there upwind suburban or urban areas containing more than 10,000 people within 20-km? (12 miles)	___	___
136	Are there cities containing more than 75,000 people within 20-km? (12 miles)	___	___
137	Are there upwind cities within 40-km? (25 miles)	___	___

Comments:

Sketch of NADP/NTN Field Site

N

W

E

S

Site Name ____________
Site Number ____________
Date of Visit ____________
Name of Surveyor ____________
Scale ____________

Draw additional sketches on back of preceeding pages.

SECTION 2
DOR 2/86

Aerochem Metrics Sampler

System Check.

		Yes	No
201	Model # ____________ ID # ____________		
202	What type of power does collector have? (circle) (a) AC only (b) AC with aerochem trickle changer/battery (c) battery only (d) battery with external AC powered charger (e) Solar (f) Other	________	
	If Solar Power, Enter 203 thru 206:		
203	Manf. ____________________ Model ________		
204	Number panels ________ Area of each ________		
205	Panels facing ________ Angle from horz. ____		
206	List any objects that may shade panels during hours of 8 am to 4 pm. ____________________		
207	Is there evidence of battery electrolite spillage?	___	___
208	Has collector failed to operate during last year because of a power failure?	___	___
209	Is the collector on a platform?	___	___
210	How high is platform?	____	in.
211	Is the height above ground standard	___	___
212	Is collector level?	___	___
213	Is collector stable?	___	___
214	Is the collector standard, base not enclosed?	___	___
215	What is the collector orientation (wet bucket is to N S E W)?	________	
216	Is the precipitation sensor old or new type?	________	
217	Is screw head of sensor orientated away from dry bucket?	___	___
218	Is sensor clean?	___	___

Yes No

219 Is sensor gap between baseplate and grid constant? ___ ___

220 What is the sensor gap distance? ________ in. ________ mm

221 Are buckets installed properly? ___ ___

222 Are buckets held with tie down strap (springs)? ___ ___

223 Is the lid in correct wet/dry position? ___ ___

Does The Collector Have

224 Aluminum snow roof? ___ ___

225 Polycarbonate snow roof? ___ ___

226 Polycarbonate lid cover? ___ ___

227 Heated lid pad ___ ___

228 Other ________________ ___ ___

229 Snow roof orientated properly? ___ ___

230 How many counter weights does collector have? ________

231 What are their sizes? 2 x ______ 2 x ______ 2 x ______ 2 x ______

232 Are counter weights correct for type lid? ___ ___

233 What is the clutch type, 1" or 1.5"? ________

234 Is the clutch face worn? ___ ___

235 Are the alignment of bars ok? ___ ___

236 What is the collector distance from rain gauge? ________ ft ________ m

237 Is the collector bucket rim within ±0.3 M (12 inches) of the same height as the top of the Belfort gauge? ___ ___

238 Is collector connected to rain gauge event marker? ___ ___

Performance Check.

239 Measure temperature of sensor at 1/3 from top. ________ °C

240 Measure output voltage to rain gauge while closed. ________ V

241 Tenson to lift lid slightly with spring scale. ________ g

242 Measure distance of lid from base with bucket in ________ mm

243 Does the lid seat properly on wet bucket? ___ ___

Yes No

Add several drops of water to sensor plot near top of sensor grid.

244 How long (seconds) does it take for the bucket cover to move from wet to dry bucket. ____ sec

245 Does sampler open smoothly and come to rest on dry bucket? ____ ____

246 Does it stay there on dry bucket? ____ ____

247 Does the lid seat properly on dry bucket? ____ ____

Observe condition of underside of bucket cover. Does it have:

248 Split polyethylene or degraded polyurethane ____ ____

249 Dirt or mildew? ____ ____

250 Measure output voltage to rain gauge while open. ____ V

251 What is the maximum sensor temp. observed after 5 to 10 min. ____ min ____ °C

Remove Wet Bucket

252 Blow off water. Does bucket cover return to wet side? ____ ____

253 Measure distance of lid from base with wet bucket removed. ____ mm

254 Difference of (241) ____ mm - (252) ____ mm = ____ mm

IF Diff < 3 mm (1/8") determine why?

255 How many Belfort gauge test weights will bucket cover lift when sensor is activated? (3 max.) ____

256 Is clutch OK? ____ ____

257 Test sensor with series of resistors until one opens the bucket. Open value. ____ k

258 Does sensor: ____

A. Heat continuous

B. Not heat

C. Operate properly

Quiz operator about collector's past operation. Take this information down, along with your observations and:

(1) Make necessary simple adjustments or repairs. Explain below what you did. Verify operation by retesting.

(2) Make recommendations for more extensive repair. Explain below.

(3) Guide operator through S. Dossett's troubleshooting manual if there are questions.

Operator or Site Visitor Comments.

Belfort Rain Gauge

301 **Model #** ______________ **S/N** ________________

System Check.

		Yes	No
302	Is the gauge level?	___	___
303	Is the gauge stable?	___	___
304	Is the collection bucket level?	___	___
305	Is the opening round?	___	___
306	Is gauge top approximately 1.5 m (59") ± 0.5 m (20") above ground?	___	___
307	If gauge is on a platform, describe the size, height of platform.	________	
308	What is rain gauge distance from sampler? _____ft	________m	
309	Is the access door of the rain gauge on the down wind side of the predominant wind path?	___	___
310	Does the rain gauge have an alter shield?	___	___
311	If rain gauge is inoperative, how does operator obtain daily/weekly precipitation information? ______________________________		
312	Is there a back-up rain gauge within a half mile (805 m)? distance ________ direction ________	___	___
313	Does site have NADP sand bottle weights?	___	___
314	Is the rain gauge calibration checked twice per year?	___	___
315	In winter, is the funnel removed and is an antifreeze and/or oil mixture put in bucket?	___	___
316	Except during winter when antifreeze is present, is catch bucket emptied every Tuesday?	___	___
317	Is the catch bucket corroded or dirty?	___	___
318	Is excessive dust present inside the gauge?	___	___

		Yes	No
319	Is the pen recording a clear trace?		
320	Is the pen offset one day on the chart as recommended by NADP?		
321	Is the gauge pen (not even pen) set to correct time?		
322	Is the pen located at the correct hour of the day, expressed as local time, within ± 1 hour? Give hour ______________.		
323	Are event marks made when the sampler opens and closes?		
324	How many hours difference are there between the event marker and the correct time?		
325	Is the clock ticking?		
326	Is clock battery operated?		
327	Dampening fluid level approximately 0.25 in from top?		
328	Are zero adjustments made using both coarse and fine knobs?		
329	Does the pen traverse the chart time line within ± 1 hour?		
330	Is gauge in cal (error < .1").		
331	Point where error is .1" or greater.		
332	Gauge calibrated by RTI.		

Calibration Check.

Have the site operator remove the top cover of the gauge, exposing the collection bucket. Jiggle the bucket to cause a deflection of the pen and enter initials, date, and "removed for audit" on the chart. Store chart. Have operator remove the recorder drum and install a new chart. Label the new chart with the site name, date, and time and the auditor's initials. Remove the collection bucket, install the weight support device, and zero the pen on the chart.

(1) Proceed to test the response of the rain gauge to various test weights as follows.

a. Rotate the drum by hand for approximately 0.25 inch and mark the chart reading as "baseline."

b. Carefully place calibrated weights, each equivalent to 1 inch rain, on the weight support and rotate the drum after each weight. Use a total of 12 weights.

c. If the response at any loading differs by more than 0.1 inch from expected value, calibrate the gauge.

(2) Zero the pen on the chart repeat (1).

Remove the audit chart and have station operator replace the original chart on the drum and set the pen to the correct day and hour. Transfer results from gauge chart to Table A-1.

Enter Comments her and/or on Table A-1. ______________________

TABLE A-1. RESULTS FOR BELFORT RAIN GAUGE CHECK

Site # ____________________ Site Name ____________________
301 Belfort Gauge Model # ______________ S/N ________________
Date of Visit ____________________
333 Gauge Calibrated by RTI Yes ___ No ___

NO ADJUSTMENT

Sum of Audit Weights, Inches	Gauge Chart Reading, Inches	Difference Inches
baseline		
1.0		
2.0		
3.0		
4.0		
5.0		
6.0		
7.0		
8.0		
9.0		
10.0		
11.0		
12.0		

PEN SET TO CHART ZERO

Sum of Audit Weights, Inches	Gauge Chart Reading, Inches Before Calib.	Difference Inches
baseline		
1.0		
2.0		
3.0		
4.0		
5.0		
6.0		
7.0		
8.0		
9.0		
10.0		
11.0		
12.0		

Sample Collection Procedures

	Yes	No
Sample Handling.		
401 Does operator approach sampler from downwind direction?	___	___
402 Is the sample bucket changed if, after seven days, no precipitation has occurred?	___	___
403 Does the operator check the collector weekly, noting lid movement check on Belfort chart?	___	___
Have operator describe procedure followed during a bucket change. Answer the following questions.		
404 Is bucket checked for contamination before removal?	___	___
405 Is bucket or top held only on outside surface?	___	___
406 Is open bucket ever placed on the ground?	___	___
407 Is lid placed on bucket before removal?	___	___
408 Is bucket top securely attached before transporting sample to home laboratory?	___	___
409 Is bucket placed in plastic bag and then in shipping box before transport to the field laboratory?	___	___

Comments ____

____

____

____

Systems Check of Field Laboratory

		Yes	No
501	Is there adequate space for operation?		
502	Is the space around the balance, pH and conductivity meters clean and free from dust, paint flakes, household chemicals?		
503	Is the laboratory temperature controlled between 18 (64.4°F) and 25°C (77.0°F)?		
504	Are the samples kept from direct sunlight during analysis?		
505	Is equipment secure and protected from tampering?		
	Are the following manuals and leaflets available?		
506	Sample Collector Manual		
507	Belfort Rain Gauge Manual		
508	pH Meter Manual		
509	pH Electrode Leaflet		
510	Conductivity Cell Leaflet		
511	Balance Manual		
512	Field Operator's Manual - NADP		
513	Letter Updates to Field Operator's Manual		
514	Battery Charger Instructions (if used)		
	Are the following items present at the field laboratory?		
515	pH meter with electrode		
516	Conductivity meter and cell		
517	Balance		
518	Wash bottle		
519	Test tubes, polypropylene		
520	How many clean buckets with mailing boxes on hand?		
521	Does operator rotate these? (first in, first out)		

		Yes	No
	Are the following reagents and test solutions present and properly stored?		
522	Distilled or deionized water	___	___
523	Standard KCl solution, 75 μmho/cm	___	___
	Note preparation date	________	
524	pH 4.01 buffer solution	___	___
525	pH 7.00 buffer solution	___	___
526	Are pH buffers stored at room temperature?	___	___
527	pH electrode test solution	___	___
	Note preparation date	________	
528	Is the pH electrode test solution stored at room temperature?	___	___
529	pH electrode filling solution	___	___
530	Has operator incorporated any item into his laboratory procedure not specified in the NADP Operator's Manual? If yes, describe. ____________ ____________________	___	___
531	Does operator weigh sample, lid, and contents before removing aliquot?	___	___
532	Does operator know the minimum amount of sample required before doing a site analysis? (70-75 mL)	___	___
533	How much time elapses between sample bucket removal and shipment?	________	
534	Operator's contact for technical questions?	________	
535	Operator's contact for shipping problems, supplies?	________	
536	Types of technical problems encountered and how they were resolved?____________ ____________________ ____________________ ____________________		

Inspect the FORF and rain gauge charts for past 10 weeks. Complete Table A-2.

TABLE A-2. RECORDS CHECK

Date Bucket Off	Rain Gauge Precip. in.	Sample Weight Precip. in.	Cond. Distilled Water µS/cm	Cond. Correction Factor	Cond. Sample µS/cm	pH Check Sample	pH Precip. Sample

Compare a FORF with corresponding rain gauge chart.

FORF Precip. record Bucket On ____________ Bucket Off ____________

	Tues.	Wed.	Thur.	Fri.	Sat.	Sun.	Mon.	Tue.
Site Values								
Rain gauge chart Survey Values								

		Yes	No
	Records Check.		
537	Are copies of Field Observer Report Forms (FORF) kept on file?		
538	Examine FORFs. Are they filled in completely?		

		Yes	No
537	Are the FORF entries legible and neat, with no erasures, and errors removed by one line through original data?		
540	Does operator know how to request additional supplies?		
541	Are copies of Belfort rain gauge charts kept on file?		
	Are charts documented with:		
542	Date and time of chart installation?		
543	Date and time of chart removal?		
544	Site identification?		
545	Event marks?		
546	Time adjustments?		
547	Compare FORF entries to rain gauge chart amounts as determined by the RTI representative. If there are any noted discrepancies enter on Table 2.		
548	Have the test solutions been measured each time?		
549	Does the measured pH agree with the stated pH within 0.1 pH unit in each instance?		
550	When agreement within specifications is not found, what action does the site operator take?		
551	Does the site operator have a file of all memoranda and letters issued concerning field operations?		
552	Does the site operator have any questions about the contents of the memoranda and letters?		
553	If question 7 is answered "yes", list the question(s) and the pertinent memoranda or letter.		
554	Does the operator have any questions concerning the quarterly USGS audit of pH and conductivity?		

Comments

pH

The auditor is to ask the site operator to determine the pH of test solutions in exactly the same way as for a precipitation sample. The auditor is to give the operator the following test solution (contained in a polyethylene bottle) for testing.

- Solution of simulated precipitation, the same one(s) used to test conductivity meter.

The auditor is to observe the operator carry out his standard procedure for determining pH as given in Section 3.3.3 of Reference (4). The auditor is to allow the site operator to work alone and is to answer the following questions concerning the operator's adherence to standard procedures for calibration of the pH meter and testing of samples.

Data from test to be entered by site operator on a FORF as a normal rain sample.

TABLE A-3. SURVEY RESULTS FOR pH

601 Site pH Meter: Make ________ Model ________
602 Site pH Electrode: Make ________ Model ________

Solution	Site Value (pH units)	Expected or Audit Value (pH units)	Difference (Site-Audit)
603 Site's H_2SO_4 Check Sol'n			
604 Simulated Rain Sample __			

	Yes	No
605 Is electrode furnished by CAL?		
606 How is the pH electrode stored between analysis sessions?		
607 Is pH electrode properly connected to the rear of the meter?		
608 Is the electrolyte fill hole of the electrode open during analysis.		
609 Does the operator rinse the electrode in deionized water and blot off drops prior to use?		

		Yes	No
610	Is meter standardized with pH 7 buffer solution by adjusting STANDARDIZE control?	___	___
611	Is meter response to pH 4 buffer set by adjusting SLOPE control?	___	___
612	Is electrode rinsed with deionized water and blotted between pH 7 and 4 buffers?	___	___
613	Is electrode tip kept from contact with bottom of test tube?	___	___
614	Does site use the 4 ml standard test tubes?	___	___
615	Is pH of electrode test solution determined using two aliquots of solution.	___	___
616	Are any adjustments made to pH meter?	___	___
617	Do at least 2-3 minutes time elapse between inserting electrode and recording final reading?	___	___
618	Is the electrode response slow?	___	___

Conductivity

The auditor is to ask the site operator to determine the conductivity of test solutions in exactly the same way as determined for a precipitation sample. The auditor is to give the operator the following test solutions (contained in polyethylene bottles) for testing.

- Solution of simulated precipitation (the same one used to test pH meter)

The auditor is to observe the operator carry out his standard procedure for conductivity as given in Section 3.3.3 of Reference (4). The auditor is to allow the site operator to work alone and to answer the following questions concerning adherence to standard procedures for internal meter checks, calibration and sample analysis.

Data from test to be entered by site operator on a FORF as a normal rain sample.

TABLE A-4. SURVEY RESULTS FOR CONDUCTIVITY

701 Site Conductivity Meter: Make ________ Model ________ S/N ____

702 Site Conductivity Cell: Make ________ Model ________ S/N ____

Solution	Site Value (µmho/cm)	Audit Value (µmho/cm)
703 Site DI H_2O	________	
704 Site's 0.0005M KCl	________	
705 Simulated Rain Sample (Corrected)	________	________

	Yes	No
706 Does site have a YSI type cell?	__	__
707 Is the YSI type conductivity cell used in the recommended (inverted) manner?	__	__
708 Does site conductivity meter have calibration adjustments?	__	__
709 Is the conductivity meter calibrated before beginning test run?	__	__
710 Is the conductivity cell rinsed thoroughly with deionized water between samples?	__	__

		Yes	No
711	Is the conductivity standard tested before deionized water?	___	___
712	Is the conductivity cell rinsed with an aliquot of sample then another aliquot of the sample added and measured? (YSI type cell)	___	___
713	Are sample conductivity values corrected for the measured value of the conductivity standard (i.e., sample measured x standard value ÷ standard measured value = sample corrected)?	___	___
714	Is the conductivity cell rinsed with deionized water before storing?	___	___
715	How is conductivity cell stored?	________	

Mass

As part of the performance survey, the station operator is to prepare the balance for use and weigh a number of weights to be supplied by RTI.

Weights are to be added to the balance one at a time and the total mass measured after each addition. All data are to be entered in Table A-5.

TABLE A-5. SURVEY RESULTS FOR BALANCE

Site Name ____________________
Date of Survey ____________________
Operator's Name ____________________
Surveyor's Name ____________________

801 Balance Name __________ Balance Model Number __________

Survey Weight(s) (g)	Total Survey Mass (g)	Balance Reading (g)	Difference, g Balance Reading - Survey Weight

802 Balance Name __________ Balance Model Number __________

Survey Weight(s) (g)	Total Survey Mass (g)	Balance Reading (g)	Difference, g Balance Reading - Survey Weight

APPENDIX K

STANDARD OPERATING PROCEDURE
FOR
PERFORMANCE AUDITING
METEOROLOGICAL INSTRUMENTS AT DRY
DEPOSITION MONITORING SITES

Standard Operating Procedure

for

Performance Auditing

Meteorological Instruments at Dry Deposition Network Monitoring Sites

by

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Disclaimer: This Standard Operating Procedure is a statement of a procedure used within the Environmental Monitoring Systems Laboratory/RTP as of the approval date. It is subject to revision and must not be construed as an EPA approved procedure generally applicable to the activities of other organizations. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Approved by:

Kenneth Caviston — 10/18/88
Kenneth J. Caviston Manager — Date
Quality Assurance Laboratory

10/18/88
Dr. William J. Mitchell — Date
Technical Monitor

Effective Date: When Approved

Table of Contents

Section 1. Equipment and Supplies

Section 2. Preparations for Audit

Section 3. Audit Procedures

Appendix Audit Data Forms

Section 1. Equipment and Supplies

General

Audit Forms, clipboards, pens
Tubing, fittings, extension cord, gang plug and tools
Two-way radios, 1 gallon container
Compass, tripod, site declination from USGS Geomagnetic Field Program (for wind direction sensor orientation)

Temperature

Dual channel RTD
Insulated water baths (2)

Relative Humidity

Portable motor-operated psychrometer or dewpoint hygrometer and appropriate tables or programmed calculator.

Wind Speed & Direction

Climatronics test fixture or equivalent synchronous motors (600,1800 RPM) & couplings to fit anemometer shaft
Extension cord
Climatronics WM-III/F460 wind direction test fixture or equivalent

Rainfall

Graduated 50 ml burette, Class A
Water for above

Solar Radiation

Factory certified pyranometer
DVM (digital voltmeter) and short leads
Calculator or Computer

Section 2. Preparations for Audit

Meteorological

1. Check burette and all instruments for breakage, signs of misuse and cleanliness.

2. Check calibration of RTD's, psychrometer and DVM. Are the calibration certificates within 6 months and do the instruments agree with laboratory standards?

3. Pack all equipment and supplies.

4. Check with site operators, network coordinator or other appropriate people to determine audit schedule, and changes in site equipment and/or procedures since last audit.

Section 3. Audit Procedures

General

1. Upon arrival at the audit site, inspect all audit equipment for transit damage.

2. Before starting the audit, fill in the header information on all forms.

3. Before disconnecting any site instrument or sampler from its ambient sampling mode, have the station operator make a note on the data acquisition system to indicate an audit is being performed. (Start Time) Log in, in station Log book.

   NOTE: All instrument outputs should be converted by the station operator to engineering units (e.g. ppm, ppb) by using the same procedures used to convert the ambient data.

4. After the conclusion of the audit and reconnection of all site instruments, record the stop time. Each auditor must also sign the log book and the data sheets.

5. While conducting the audit note the operator's familiarity with the QAPP, the condition of the equipment and site cleanliness and appearance.

6. Sign and date the data sheets and ask the station operator to sign and date them.

   NOTE: If there is a significant difference between the site value and any audit value, check to be sure the audit equipment was properly connected and operated. If everything seems to be in order, then repeat the audit to be certain that the difference can be repeated.

Wind Direction Sensor Orientation

1. Set up the compass with telescope on the tripod approximately 100 yards south of the meteorological tower. (Make sure compass is level)

2. Look through the telescope at the wind direction (WD) sensor. Move the tripod right or left until the wind direction sensor is in alignment with the wind speed sensor. When properly aligned,

only the wind direction sensor will be visible when viewed through the telescope.

3. Once alignment is obtained, and compass is level release the compass pointer and take reading a reading.
4. Record the compass reading in degrees on the audit data sheet.
5. Record the correct magnetic declination for the site which was previously obtained from U.S.G.S.
6. Determine the difference between the compass reading and the U.S.G.S. value and record the difference on the audit data sheet.
7. Check the WD/WS sensors for proper vertical position by viewing the sensors through the telescope and using the cross hairs as a reference. If the sensors and vertical cross hair are parallel to each other, the vertical position of the sensors is correct. If they are not, inform the site operator of this condition.
8. Leave the compass and tripod in this position, this will allow the tower to be repositioned properly when it is raised after completion of the audit.
9. Place the meterological sensors that are mounted on the tower in the off line status, lower the tower and proceed with the remainder of the meteorological audit. After completing the audit, raise and secure the tower and check the tower alignment through the telescope.
10. Move the compass either to the west or east of the tower and determine if the crossarm is level and the WD/WS sensors are vertical.
11. Inform the station operator if the sensors are found not to be positioned vertical.

Temperature

1. Unpack the RTD; and examine the two sensors to make sure they are still inserted all the way to the bottom of the black plastic sleeves.

   Caution: The RTD sensor must not be inserted into water without the plastic sleeves installed.

2. Connect the RTD sensors to the correct input leads of the RTD read-out box (number 1 to 1, 2 to 2).

3. Connect the RTD read-out box to a 110 volt power source and turn on the main power switch. Turn the degree selector switch to degree C position.

   NOTE: The electronics in the read-out box must warm up for 30 minutes before any readings are taken.

4. Fill the two insulated water baths with distilled water that is at a temperature of 15 degrees C to 25 degrees C.

5. After the RTD electronics have warmed up sufficiently, remove the station temperature probes T1 (Ambient) and T2 (delta) from their housings.

6. Insert the T1 temperature probe into the plastic sleeve with RTD sensor # 1, and then place it into one of the insulated water baths. Place the T2 temperature probe in the plastic sleeve with RTD sensor # 2 and place it in the second water bath.

7. Allow sufficient time for the temperature readings to stabilize before taking any readings. This may take 20 minutes.

8. Check to be sure the station I.D. number and date are written at the top of the temperature calculation worksheet.

9. At the beginning of a 5 minute averaging period on the DAS, begin recording the temperature readings for RTD 1 and 2 every 15 seconds and continue for the entire 5 minute period. The station operator can tell you when to begin and stop taking the readings. Record all values on the worksheet.

10. Determine the average temperature readings for each RTD and record the results on the audit data form.

11. Determine the delta temperature by finding the difference between the average reading from RTD 1 and 2. Record this reading on the audit data sheet.

12. Record on the audit data sheet the site temperature readings during the same 5 minute averaging period for T1 and T2 using the information in the Data Acquisition System.

13. Determine the differences between the audit temperatures and the site temperatures for T1 and T2. If differences are greater than the limits established in the QAPP, repeat the test following the instructions in steps 11-15. Proceed to the next step if temperature differences are within limits of the QAPP.

14. Pour out the water in the two water baths and fill each with crushed ice, add a small amount of distilled and stir contents. The temperature of the baths should be at to 0 degrees C.If not,

add more ice and stir until a temoerature of 0 degrees C is obtained.

15. When a stable temperature is obtained, repeat steps 9-13.

16. Replace temperature sensors T1 and T2 in the respective housings.

Wind Direction

1. Remove the wind vane from the sensor shaft and check the assembly by rotating the shaft and listening and feeling for unusual sounds and roughness in the bearings.

2. Remove the wind direction sensor from the crossarm by loosening appropriate set screws.

3. Attach the wind direction sensor to climatronics WM-III/460 wind direction test fixture and connect the test fixture signal cable into the plug located on tower crossarm.

   NOTE: Sensor and direction test fixture are keyed to insure proper alignment.

4. Attach the test fixture degree wheel to the sensor shaft and set it to read 0 degrees (by allowing the locking mechanism to "lock-in" at the 0 mark on the scale). Record the audit value (i.e setting on degree wheel) and the sensor value taken from the Data Acquistion System (DAS) on the audit sheet.

5. Take a minimum of six additional readings between 0 and 360 degrees and record results on the audit data sheet.

6. Perform a linear regression analysis of the audit values(x) and the sensor values (y).

7. Replace WD sensor onto crossarm and replace the wind vane onto the sensor.

Wind Speed

1. Remove the anenometer cups from the shaft and rotate the shaft slowly by hand to see if any unusual bearing condition is detected, as was done in step 1 for the WD sensor bearings.

2. Check the WS reading on the DAS when the shaft is held stationary, record the reading on the audit data sheet.

3. Spin the sensor shaft at 600 RPM by attaching the motor to the sensor shaft. Once the reading on the DAS has stabilized, record on the audit data sheet.

4. Repeat step 3 using the 1800 RPM motor.

5. Convert the RPM to meter/second using the appropriate equation. Record these meters/second (M/S) values on the audit data sheet. For the climatronics 460 with vinyl cups, the audit values in M/S for the 600 and 1800 RPM motors are 14.304 and 42.51, respectively.

6. Perform a linear regression analysis of the audit readings (x) and the sensor readings from the DAS (y).

7. Replace the anemometer cups on the sensor shaft.

Solar Radiation

1. Conduct the Solar Radiation audit as close as possible to noontime.

2. Place the solar radiation sensor to off-line status.

3. Check to see if the station solar radiation sensor is level and observe the surroundings for interferences. Record findings on audit data sheet.

4. Install audit pyranometer as close as possible to the station sensor without interfering with it.

5. Connect a DVM to the audit pyranometer.

6. At the beginning of a 5 minute averaging period on the site DAS, begin taking millivolt readings from the audit DVM every 10-15 seconds for the entire 5 minute period. Record the DVM readings on the solar radiation worksheet. Repeat test 2 more times.

7. Average the millivolt readings and convert to watts/meter using the calibration data furnished with the audit pyranometer. Record this value on the audit data sheet. Also, record the reading from the site DAS for the same 5 minute period. Calculate % difference and enter result or audit data sheet.

8. Place the solar radiation sensor in on-line status.

Relative Humidity (%RH)

1. Locate the audit psychrometer as close to the station sensor as possible without interfering with the station sensor.

2. Wet the wick on the wet bulb thermometer using the distilled water supplied with the psychrometer.

3. Turn on audit psychrometer and allow the temperatures (Dry & Wet) to stabilize.

Caution: Observe the wet bulb thermometer closely so a reading can be taken as soon as it stabilizes. If the wick begins to dry an incorrect wet bulb temperature will result and the audit value could be seriously in error.

4. Record the wet and dry bulb temperatures and also the sensor response from the DAS on the audit data sheet.

5. Repeat the test at least 2 more times, wetting the wick on the wet bulb thermometer before each test.

6. Determine the temperature depression (wet bulb minus dry bulb) from the three tests. Convert to % relative humidity using the appropriate charts. Record the values on the audit data sheet. Record the corresponding averaged readings from the station DAS.

7. Calculate the % difference for each set of readings.

Rain Gauge

1. Place the rain gauge in the off-line status.

2. Mount the 50 ml burette so that the water released will drip into rain gauge. Carefully fill the burette with water. Record the volume of water.

3. At the beginning of a 5 minute averaging period on DAS, open the stopcock and begin releasing water into the rain gauge.

   NOTE: Release water at a rate that will not cause a TIP to occur in less than 5 seconds.

4. Count the number of tips as the water is released from the burette. After the ninth tip occurs, slow the release of water.

5. Immediately after the tenth tip occurs, turn off the stopcock on the burette. Read the volume of water released from the burette and record on the audit data sheet, calculate inches of rain from the water volume and enter on the data sheet.

   NOTE: The ten (10) tips must occur within the 5 minutes averaging period on the DAS.

6. Record the number of tips taken from the DAS. Repeat steps 2-6 two more times.

7. Return the rain gauge to on-line status.

Page 1 of 1

Meteorological Field Audit Data Sheet
(Wind Speed & Direction)

Station (Name/Number)______________________ Date__________
Address ______________________ Start Time__________
T_a __________ °C; P_a __________ mm Hg; Auditor __________

Speed Audit System __________ Model __________ Serial # __________
Reference __________ Calibration Eqn. __________

Station System __________ Model __________ Serial # __________
Sensor Level __________ Serial # __________
Last Cal. Date __________ Frequency __________ Method __________
Calibration equation __________

Direction Audit Syst. __________ Model __________ Serial # __________
Reference __________ Calibration Eqn. __________

Station System __________ Model __________ Serial # __________
Sensor Level __________ Serial # __________
Last Cal. Date __________ Frequency __________ Method __________
Calibration equation __________

Observations & Comments __________

Audit Results

Test No.	Wind Direction				Wind Speed			
	X Audit Direction degrees	Site Response voltage	Site Response Y degrees	Diff. Y - X degrees	Tachometer RPM	Tachometer X m/sec	Site Y m/sec	Diff. Y - X m/sec
1					600	14.304		
2					1800	42.510		
3								
4								
5								
6								
7								
8								
9								
10								

Direction
site = __________ X actual + __________
(slope) (intercept)
correlation coeff. squared r^2 = __________

Speed
site = __________ X actual + __________
(slope)
r^2 = __________

conversion factor for wind speed from rpm to m/s = __________

Verified by ______________________ Date __________

Meteorological Field Audit Data Sheet
(Temp., RH and solar)

Station (Name/Number) ____________________ Date ________
Address ____________________ Start Time ________
T_a ________ °C; P_a ________ mm Hg; Auditor ____________

Temp. Audit system ____________ Model ________ Serial # ________
Reference ____________ Calibration Eqn. ____________

Station System ____________ Model ________ Serial # ________
Last Cal. Date ________ Frequency ________ Range ________
Calibration Method ____________________
Ambient Sensor S.N. ________ Cal.Eqn. ____________
Diff. Sensor S.N. ________ Cal.Eqn. ____________

I. Temperature: (5 min. averages from worksheet page 3 and site DAS)

Test	Test #	Parameter	Audit System	Site Response	Difference (site-audit)
Low Temperature (0°C)	1	T_1			
		T_2		______	______
		ΔT			
	2	T_1			
		T_2		______	______
		ΔT			
High Temperature (15-25°C)	3	T_1			
		T_2		______	______
		ΔT			
	4	T_1			
		T_2		______	______
		ΔT			

Summary: Average Diff. T_1 ________ °C
(Site-Aud.) ΔT ________ °C

Comments: ______________________________
____
____
____
____

II. Solar radiation (watts/m²):
(5 min. averages from worksheet page 4 and site DAS)

Test #	Audit System	Site Response	% Difference (site-audit)x100% / audit
1			
2			
3			

Summary: Average % difference: ______________ %

Comments:____

III. % Relative Humidity:

Test #	Wet Bulb °C	Dry Bulb °C	Depression (D-W)°C	Audit System	Site Response	% Difference (site-audit)x100% / audit
1						
2						
3						

Summary: Average % Difference: ______________ %

Comments:____

Tipping Bucket Rain Gauge Audit

MODEL #: ________________ S/N #: ________________

POINT	AUDIT mL H_2O	# of tips	Audit, inches of rain[1]	SENSOR RESPONSE
1				
2				
3				
4				
5				

[1] $\frac{\text{mL water}}{473}$ = inches of rainfall (theoretical)

Comments: ____

____

____

____

Crossarm Orientation

Compass reading observed ________________

Declination (USGS) ________________

Degrees Difference ________________
(Compass reading minus USGS declination)

Were WS and WD sensors vertical

As observed from the North or South ________________

As observed from the East or West ________________

Meteorological Worksheet

Solar Radiation Calculations

DATE: ______________ Site: ______________________________

Begin Time: ______________ End time: ______________

(Readings taken every 15 seconds for 5 minutes)

Reading #	MV Response Test 1	Test 2	Test 3
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			

Summary:

Test #1:

$\bar{X}$ = ______________ MV

conversion to watts/m²:

$\frac{\_\_\_\text{MV} \times 697.3}{\text{MV/cal cm}^{-2}\text{min}^{-1}}$ = ______ wat /m

Test #2:

$\bar{X}$ = ______________ MV

conversion to watts/m²:

$\frac{\_\_\_\text{MV} \times 697.3}{\text{MV/cal cm}^{-2}\text{min}^{-1}}$ = ______ wa /

Test #3:

$\bar{X}$ = ______________ MV

conversion to watts/m²:

$\frac{\_\_\_\text{MV} \times 697.3}{\text{MV/cal cm}^{-2}\text{min}^{-1}}$ = ______ wa /

Comments: ______________

K-15

SUMMARY SHEET

1). SITE & APPEARANCE

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2). OPERATOR'S FAMILIARITY WITH NETWORK PROCEDURES/PROTOCOLS

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3). RECOMMENDED CORRECTIVE ACTION

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AUDITORS SIGNATURE:

____________________ ____________ DATE

____________________ ____________ DATE

APPENDIX L

STANDARD OPERATING PROCEDURE
FOR
PERFORMANCE AUDITING
OZONE ANALYZERS AT DRY DEPOSITION
MONITORING SITES

Standard Operating Procedure

for

Performance Auditing

Ozone Analyzers at Dry Deposition Monitoring Sites

by

J.C. Holland, J.M. Pleasant, M.F. Miller, and R.E. Brande

NSI Technology Services Corporation
Research Triangle Park, NC

Disclaimer: This Standard Operating Procedure is a statement of a procedure used within the Environmental Monitoring Systems Laboratory/RTP as of the approval date. It is subject to revision and must not be construed as an EPA approved procedure generally applicable to the activities of other organizations. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Approved by:

Kenneth J Caviston
Kenneth J. Caviston, Manager
Quality Assurance Laboratory

10/15/88
Date

Bill Mitchell
Dr. William J. Mitchell
Technical Monitor

10/18/88
Date

Effective Date: When Approved

Table of Contents

Section 1. Equipment and Supplies

Section 2. Preparations for Audit

Section 3. Audit Procedures

Appendix A. Audit Data Forms

Section 1. Equipment and Supplies

General

Audit forms, clipboards, pens
Tubing, fittings, and tools

Ozone

TECO Model 49PS Ozone Calibrator or equivalent (w/6 feet of Teflon tubing)
Zero air system: Ozone generator, fresh Purafil, fresh silica gel

Section 2. Preparations for Audit

1. Check with site operator(s), network coordinator or other appropriate people to determine audit schedule and changes in site equipment and/or procedures since last audit.

2. Check the calibrator for correct operation and valid verification date.

3. Test zero air system for correct operation by hooking up to 49PS and see if you get a zero reading.

4. Pack all equipment and supplies.

Section 3. Audit Procedures

General

1. Upon arrival at the audit site, inspect all audit equipment for transit damage.

2. Log audit team on-site in station log book.

3. Before starting the audit, fill in the header information on all forms.

4. Before disconnecting any site instrument or sampler from its ambient sampling mode, have the station operator make a note on the data acquisition system to indicate an audit is being performed. (Start Time)

NOTE: All instrument outputs should be converted by the station operator to engineering units (e.g. ppm, ppb) by using the same procedures used to convert the ambient data.

5. After the conclusion of the audit and reconnection of all site instruments, record the stop time in log book. Each auditor

must also sign the log book and the data sheets.

6. While conducting the audit, note the operator's familiarity with the QAPP, the condition of the equipment and site cleanliness and appearance.

7. If there is a significant difference between the site value and any audit value, check to be sure the audit equipment was properly connected and operated. If everything seems to be in order, then repeat the audit to be certain that the difference can be repeated.

8. This audit procedure generally follows the procedure for ozone monitor audits in Volume II, Section 2.0.12 of the QA Handbook. However, there are significant differences between this procedure and that in the handbook, because the latter applies to monitors assessing trends in ozone levels that affect human health in populated area.

Ozone Audit

1. Assemble the audit equipment and turn it on.(Note the 49PS will not operate until the ozone source lamp has reached 50 degrees C.) Make sure the P/T switch is energized; the 49PS will then automatically correct for changes in pressure and ambient temperature. Allow the zero air system and 49PS to warm up for one hour. Record the readings and settings for the audit system (49PS) and the station analyzer on the audit data sheet.

2. Turn on the zero air system and adjust the two pressure gauges in the 49PS to 10psig. This will allow excess flow through the ozonator, output manifold and the flow meters.

3. Notify the station operator so he can mark the data acquisition systems to indicate an audit has started. Disconnect the site analyzer from the station's ambient air sampling manifold and connect it to the 49PS ozone port. Cap the sample port on the station's manifold.

4. Allow the site analyzer and 49PS to sample zero air until a stable response is obtained. Now, simultaneously read and record ten consecutive, 15 second readings from the 49PS and the Data Acquisition System's (DAS) readout for the site analyzer. Calculate the mean for the audit system, DAS, and record these mean values on the data sheet.

5. It is now necessary to generate at least four distinct ozone concentrations that cover the ozone values recorded at the site. The recommended concentrations for MCCP sites are 200, 100, and 30 ppb. Always start with the highest concentration and consecutively generate decreasing concentrations. (If desired, additional points at upscale concentrations different from those specified may be generated as well as a post audit clean dry (zero) air response.

6. Adjust the pollutant (O3 output) to achieve each desired concentration of O3 and allow the site analyzer and audit photometer to sample the audit atmosphere until a stable response is obtained. Take simultaneous readings at each concentration level as in step 4 above.

7. Calculate the mean valvue for each concentration level, for both the 49PS and the station analyser. Calculate and record the O3 concentration: [O3] = RD - RZ where: RD is the mean of the 10 photometer readings at a given level; RZ is the mean photometer reading for zero air.

8. After recording all data for the final audit concentration, reconnect the analyzer to the station sampling manifold and check for normal monitor operation. Make a note of the audit stop time and inform the station operator so he can note it on the station data acquisition system.

9. Calculate the differences at all levels and the % difference at all levels except zero. Perform a regression analysis with the audit photometer concentration as the true value on the x-axis and the station analyzer's concentrations on the y-axis. Record the slope, intercept and correlation coefficient squared (r2) on the data sheet.

10. Compare the audit results to the target data quality goals of the project as shown in the project's QA project plan and determine the conformance to these goals. Indicate on the summary data form any corrective action required where deficiencies were found.

11. Discuss the audit results with the site operator and discuss any major deficiencies found and any corrective action required.

12. Sign and date the summary data sheet and ask the station operator to sign and date it. Tear out one copy of the form and give to the station operator.

O_3 Audit Data Sheet

Station (Name/Number)______________________________ Date______

Address____________________________________ Start Time______

T_a__________ °C; P_a__________ mm Hg; Auditor____________________

Analyzer Make______________ Model____________ Serial #____________

Calibration Std.______________________ Span source______________

Last Cal. Date__________ Freq.(A)____________ Freq.(B)____________

Temp.(A)&(B)__________________ Pressure (A)&(B)________________

Zero setting__________________ Data acquisition system______________

Span setting__________________ Recorder range____________________

Instrument full scale __________ ppb

Audit system TECO 49PS Serial #__________ Cert.Date__________

Gain setting______________________________

Freq.(A)__________ Freq.(B)__________ Noise(A/B)______________

Cell Temp.(A/B)________________ °C Sample flow (A/B)______________

Clean, dry air source____

	0% FS		200 PPB		100 PPB		30 PPB	
	Audit	Site	Audit	Site	Audit	Site	Audit	Site
1 Cell A								
Cell B								
2 Cell A								
Cell B								
3 Cell A								
Cell B								
4 Cell A								
Cell B								
5 Cell A								
Cell B								
Average								
Concentration Ave.-Zero	________							
Difference (ppm/ppb)								
% Difference	________							

site = ______________ X actual + ______________
(slope) (intercept)

correlation coefficient squared (r^2) = __________

Verified by ______________________________ Date __________

SUMMARY SHEET

1). SITE & APPEARANCE

2). OPERATOR'S FAMILIARITY WITH NETWORK PROCEDURES/PROTOCOLS

3). RECOMMENDED CORRECTIVE ACTION

AUDITORS SIGNATURE:

DATE

DATE

APPENDIX M

STANDARD OPERATING PROCEDURE
FOR
PERFORMANCE AUDITING
SO_2 ANALYZERS AT
MOUNTAIN CLOUD CHEMISTRY MONITORING SITES

Standard Operating Procedure

for

Performance Auditing

SO2 Analyzers at Mountain Cloud Chemistry Monitoring Sites

by

J.C. Holland, J.M. Pleasant, M.F. Miller, and R.E. Brande

NSI Technology Services Corporation
Research Triangle Park, NC

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Approved by:

Kenneth J Caviston
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10/18/88
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Bill Mitchell
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Technical Monitor

10/17/88
Date

Effective Date: When Approved

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Section 1. Equipment and Supplies

Section 2. Preparations for Audit

Section 3. Audit Procedures

Appendix Audit Data Forms

Section 1. Equipment and Supplies

General

Audit forms, clipboards, pens
Tubing, fittings, extension cord, gang plug and tools

SO2

Certified SO2 in nitrogen cylinder,10-40 ppm or other appropriate concentration based on audit concentrations to be generated during the audit
Two-stage stainless steel regulator (CGA 660)
EMSL/QAD PM-10 flow audit system or equivalent
Zero air system: pump, Perma-Pure or silica gel drier
Portable Dilution System
Portable computer for calculating the results and printing the best fit curve
Laminar flow elements for dilution flow measurement
Laminar flow elements for pollutant flow measurement
Vacuum pump

Section 2. Preparations for Audit

1. Check with site operators, network coordinator or other appropriate people to determine audit schedule and changes in site equipment and/or procedures since last audit.

2. Check that the certified cylinder has at least 500 psi and that it has been certified within the last 12 months.

3. Check LFE's to insure they measure in the range you need for pollutant and dilution flows.

4. Test zero air system and portable dilution system for correct operation by hooking up to laboratory analyzer and observing response using a known standard such as the EPA/EMSL standards laboratory. Always insure that you have fresh silica gel.

5. Pack all equipment and supplies in a manner that ensures safe transport to the site.

Section 3. Audit Procedures

General

1. Upon arrival at the audit site, inspect all audit equipment for transit damage.

2. Log audit team on-site in station log book.

3. Before starting the audit, fill in the header information on all forms.

4. Before disconnecting any site instrument or sampler from its ambient sampling mode, have the station operator make a note on the data acquisition system and in the station log book to indicate an audit is being performed. (Start Time)

NOTE: All instrument outputs should be converted by the station operator to engineering units (e.g. ppm, ppb) by using the same procedures used by the data recovery system to convert the ambient data.

5. After the conclusion of the audit and reconnection of all site instruments, record the stop time. Each auditor must also sign the log book and the data sheets.

6. While conducting the audit, note the operator's familiarity with the QAPP, the condition of the equipment and site cleanliness and appearance, especially that of the intake manifold.

7. If there is a significant difference between the site value and any audit value, check to be sure the audit equipment was properly connected and operated. If everything seems to be in order, then repeat the audit to be certain that the difference can be repeated.

8. This audit procedure generally follows the procedures for SO2 monitor audits in Volume II, Section 2.0.12.6 of the QA Handbook. However, there are significant differences between this procedure and that in the handbook because the latter applies to monitors assessing trends in SO2 levels that affect the human health in populated areas, and thus are at a much higher concentration level.

SO2 Audit

1. Assemble the audit equipment and verify correct operation.

2. Connect the regulator to the SO2 cylinder and purge the regulator at least 2 - 3 times, using the vacuum pump.

3. Adjust and measure the Portable Dilution System's zero air flow with an appropriate LFE.

4. Notify the station operator so he can mark the data acquisition

system and log book to indicate an audit has started. Disconnect the site analyzer from the station's ambient air sampling manifold and connect it to the Portable Calibrator's sample port. Cap the sample port on the station manifold.

5. Allow the site analyzer to sample zero air 5-10 minutes until a stable response is obtained. Now read and record ten consecutive, 15 second readings from the Data Acquisition System (DAS) for the monitor. Calculate the mean and record on the audit data sheet. Also record the audit value as zero ppb on the data sheet.

6. It is now necessary to generate at least three distinct SO2 concentrations that cover the SO2 values recorded at the site. For MCCP sites, the recommended concentrations at 40, 20, 10 ppb cover the normal measurement range of the monitor to be audited. Always start with the highest concentration and consecutively generate decreasing concentrations. (If desired, additional points at upscale concentrations different from those specified may be generated as well as a post audit zero air response.

7. Adjust the Portable Dilution Systems pollutant flow to achieve each desired dilution of SO2 and measure the exact flow with an appropriate LFE. Record each flow on the data sheet and calculate the delivered pollutant concentration.

8. Allow the site analyzer to sample the audit atmosphere until a stable response is obtained. Take simultaneous readings at each concentration range as in step 5 above.

9. After recording all data for the final audit concentration, reconnect the analyzer to the station manifold and check for normal monitor operation. Make a note of the audit stop time and inform the station operator so he can note it in the station log book and on the Data Acquisition System.

10. Calculate the concentration and % differences at all levels except zero. Perform a regression analysis with the calculated audit concentrations as the true value on the x-axis and the station analyzer's concentrations on the y-axis. Record the slope, intercept and correlation coefficient squared (r) on the data sheet.

11. Compare the audit results to the target data quality goals of the project as shown in the project's QA project plan and determine the conformance to these goals. Indicate on the summary data form any corrective action required where deficiencies were found.

12. Discuss the audit results with the site operator and discuss any

major deficiencies found and any corrective action required.

13. Sign and date the summary data sheet and ask the station operator to sign and date it. Tear out one copy of the form and give to the station operator.

SO_2 Audit Data Sheet

Station (Name/Number)______________________________ Date________

Address ____________________________________ Start Time________

T_a ________ °C; P_a ________ mm Hg; Auditor __________________

Analyzer Make ____________ Model __________ Serial # ____________

Calibration Std.____________________ Span source ____________

Last Cal. Date ____________ Frequency __________ Range __________

Calibration comments ____________________________________

Zero setting ______________ Data acquisition system ____________

Span setting ______________ Recorder range __________________

Instrument full scale __________ppb LFE S/N & Type________________

Audit system ____________________ LFE S/N & Type________________

Audit std.cyl.# ______________ Pres.________psig Conc.=__________ppm

Clean, dry air source ________________________ PM-10 S/N____________

	0% FS 0	40 PPB 1	20 PPB 2	10 PPB 3
Dilution Flow				
Temp.				
LFE S/N				
ΔP				
Bar. Press.				
STP Flow				
Pollutant Flow				
Temp.	______			
LFE S/N				
ΔP	______			
Bar. Press.	______			
STP Flow				
Concentration = cyl[$F_p/(F_p+F_d)$]* X	0			
Site response (ppm/ppb) Y				
Difference (ppm/ppb)				
% Difference	______			

* F_p=pollutant flow (columns 1, 2 or 3), F_d=dilutant flow

site = ____________ X actual + ____________
(slope) (intercept)

correlation coefficient squared (r^2) = __________

Accuracy Target Goals_______ Found:______ Diff.______ Meets Goals: Y N

Verified by ______________________________ Date __________

SUMMARY SHEET

1). SITE & APPEARANCE

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2). OPERATOR'S FAMILIARITY WITH NETWORK PROCEDURES/PROTOCOLS

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3). RECOMMENDED CORRECTIVE ACTION

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AUDITORS SIGNATURE:

_________________________ ______________
DATE

_________________________ ______________
DATE

APPENDIX N

ANALYSIS OF DRY DEPOSITION FILTER EXTRACTS BY ION CHROMATOGRAPHY

4.0 ANALYSIS OF DRY DEPOSITON FILTER EXTRACTS BY ION CHROMATOGRAPHY

4.1 SCOPE AND APPLICABILITY

EPA Method 300.6 is the reference method for measurement of anions in wet deposition samples by ion chromatography. The following procedure is a modification of the reference method with additions and changes appropriate for bench used by laboratory personnel for dry deposition sample analysis.

This method is used in the determination of anions in dry deposition samples (see Figure 4-1). An aliquot of sample is injected into the eluent stream, pumped at a continuous and constant rate through a guard column, separator column, suppressor, conductivity cell, and finally to waste. Upon reaching the separator column, sample anions compete with the carbonate/bicarbonate anions in the eluent for active exchange sites on the resin beads. Different anions migrate down the resin at constant but different rates, determined primarily by the size and valence of the anion, causing the anions to elute from the separator column in discrete bands. Entering the suppressor, the anions are converted to the highly conductive acid form while the carbonate anions are converted to weakly conductive carbonic acid. A conductivity cell responds proportionately to the concentration of the analyte. An analog signal is produced, amplified, recorded on an integrator, and compared to a previously run standard curve. Ions are identified by retention time and quantified by comparison of peak heights or peak areas with solutions of known concentrations.

Any substance that has a retention time coinciding with that of any anion to be determined will interfere. For example, relatively high concentrations of low-molecular-weight organic acids interfere with the determination of chloride and fluoride. A high concentration of any one

NDDN/LAB.6.

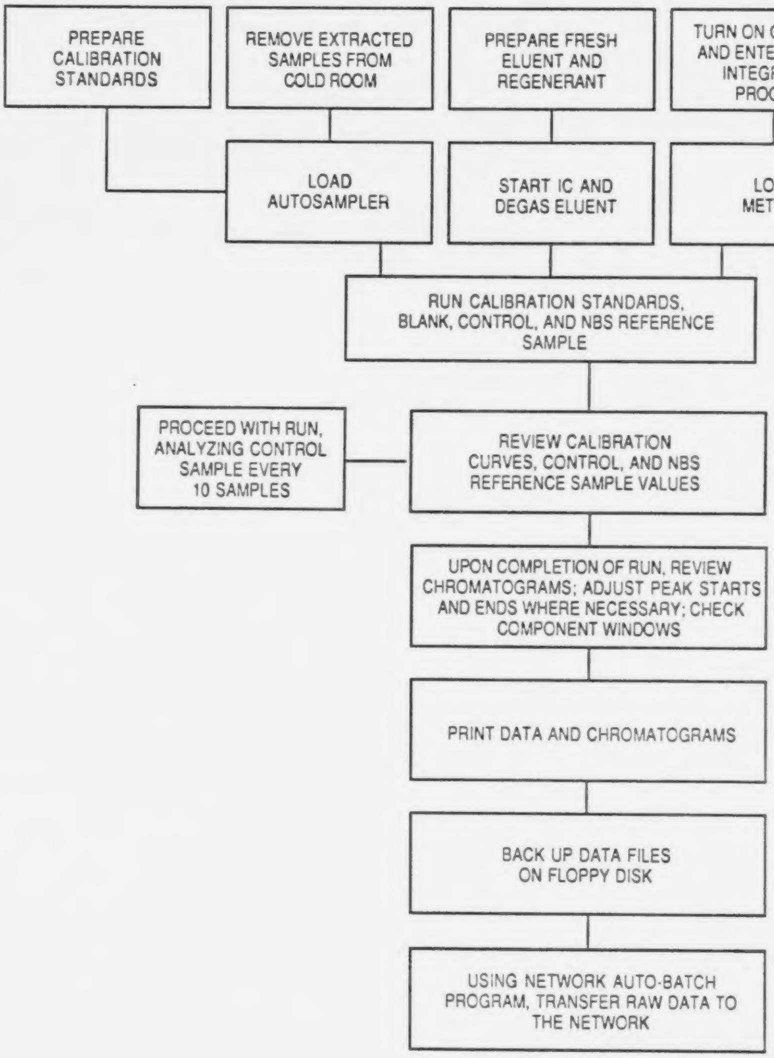

PREPARE CALIBRATION STANDARDS
REMOVE EXTRACTED SAMPLES FROM COLD ROOM
PREPARE FRESH ELUENT AND REGENERANT
TURN ON COMPUTER AND ENTER MAXIMA® INTEGRATION PROGRAM
LOAD AUTOSAMPLER
START IC AND DEGAS ELUENT
LOAD METHOD
RUN CALIBRATION STANDARDS, BLANK, CONTROL, AND NBS REFERENCE SAMPLE
PROCEED WITH RUN, ANALYZING CONTROL SAMPLE EVERY 10 SAMPLES
REVIEW CALIBRATION CURVES, CONTROL, AND NBS REFERENCE SAMPLE VALUES
UPON COMPLETION OF RUN, REVIEW CHROMATOGRAMS; ADJUST PEAK STARTS AND ENDS WHERE NECESSARY; CHECK COMPONENT WINDOWS
PRINT DATA AND CHROMATOGRAMS
BACK UP DATA FILES ON FLOPPY DISK
USING NETWORK AUTO-BATCH PROGRAM, TRANSFER RAW DATA TO THE NETWORK

Figure 4-1
FLOWCHART FOR ION
CHROMATOGRAPHY ANALYSES

U. S.
Environmental Protection Agency

National Dry Deposition Network

ion also interferes with the resolution of others. Sample dilution overcomes many interferences. To resolve uncertainties of identification or quantitation, use the method of known additions. Spurious peaks may result from contaminants in reagent water, glassware, or sample processing apparatus. Because small sample volumes are used, scrupulously avoid contamination.

4.2 EQUIPMENT AND MATERIALS

4.2.1 INSTRUMENT CONFIGURATION

The following instrument configuration is required:

1. Dionex Model 4000i Ion Chromatograph with Autoion® 100 Controller.
2. Dionex Automated Sampler (Part Number 37077).
3. Maxima® Computer Integration System.
4. Guard Column: AG4-A (Part Number 37042).
5. Separator Column: AS4-A (Part Number 37041).
6. Suppressor: Anion Micro Membrane Suppressor (Part Number 38019).

4.2.2 INSTRUMENT CONDITIONS

The following instrument conditions are required:

1. Eluent: 0.75-millimole (mM) sodium bicarbonate ($NaHCO_3$)/2.2-mM sodium carbonate (Na_2CO_3).
2. Regenerant: 0.025N sulfuric acid (H_2SO_4).
3. Eluent Flow Rate: 2.0 milliliters per minute (mL/min).
4. Regenerant Flow Rate: 3 to 4 mL/min.
5. System Pressure: 800 to 900 pounds per square inch (psi).
6. Injection Loop: 50 microliters (uL) (25 uL for Whatman filter extracts).
7. Output Range: 10 microsiemens per centimeter (uS/cm) full scale; 3 uS/cm full scale for Whatman filter extracts.

4.2.3 REAGENTS

The following reagents are required:

1. Prepare a 100X concentrated eluent stock (0.75-mM $NaHCO_3$ and 2.2-mM Na_2CO_3) by dissolving 6.30 grams (g) of $NaHCO_3$ and 23.3 g of $NaHCO_3$ in deionized water and diluting to 1 liter (L). Autoclave the solution in a polypropylene bottle to prevent growth of microorganisms harmful to the column.
2. Prepare the working eluent by diluting 20.0 milliliters (mL) of concentrated eluent to 2 L with deionized water.
3. Prepare the regenerant (0.025N H_2SO_4) by adding 2.8 mL of concentrated H_2SO_4 to 4 L of deionized water.

4.3 PROCEDURE

4.3.1 ION CHROMATOGRAPH STARTUP

Use the following procedure to start up the ion chromatograph.

1. Verify that the eluent and regenerant reservoirs have sufficient fresh solution for the run.
2. Turn on the helium tank valve, and set the regulator to 90 psi.
3. If the eluent reservoir has been disconnected since the last run or if air bubbles are suspected in the eluent line, remove the bubbles before starting the pump (refer to the instrument manual).
4. Push the START button on the controller module and IMMEDIATELY push STOP. The pump should start and the regenerant reservoir should build up pressure. (The pump has been configured for remote operation).
5. Set regenerant reservoir regulator to produce a regenerant flow rate of 3 to 4 mL/min (approximately 8 psi).
6. Using the eluent degas module, degas the eluent for at least 5 minutes.
7. Allow the system to equilibrate for 20 minutes or longer before starting the run. Baseline conductivity should be stable before beginning analysis.

8. Set the conductivity cell to remote operation.

4.3.2 CONDUCTIVITY CELL CALIBRATION

Use the following procedure to calibrate the conductivity cell.

1. Calibrate the conductivity cell monthly. Prepare a 0.10M potassium chloride (KCl) solution by dissolving 7.4555 g of KCl in 1 L of deionized water. The solution can be stored for 1 year at room temperature.
2. Prepare a 0.001M KCl solution by diluting 1.0 mL of the 0.10M KCl solution to 100 mL with deionized water. To calibrate the cell, bypass the columns and connect the pump outlet line directly to the conductivity cell. Using eluent port No. 4, pump 0.001M KCl through the cell at 2.0 mL/min. Conductivity reading should stabilize within 5 minutes and be 147 ±10 uS/cm. Adjust the calibration potentiometer until the cell reads 147 uS/cm. A deviation greater than 10 uS/cm may indicate the need to clean the cell electrodes. Follow manufacturer's instructions.

4.3.3 CALIBRATION STANDARDS

Use the following steps to prepare the standard anion stock solutions [1,000 milligrams per liter (mg/L)].

1. Using standard materials of the highest purity available, prepare nitrate and sulfate anion stock solutions by dissolving 7.2182 g of potassium nitrate (KNO_3) and 1.8141 g of potassium sulfate (K_2SO_4), dried to a constant weight at 105 degrees Celsius (°C), in deionized water and diluting to 1,000 mL. Store stock solutions in polyethylene bottles at 4°C. Prepare fresh stock solutions every 6 months.
2. Check stock solution for contamination using the following procedure:
   a. Prepare a 20-mg/L single-anion standard from each stock solution.

   b. Analyze by ion chromatography for detectable levels of anions other than the principle anion.
   c. If contamination is detected, remake the stock solution, from new stock material if necessary.

3. A properly calibrated, adjustable pipette with disposable tips is preferred over glass pipettes. Keeping glass pipettes clean and free of contamination is difficult. Plastic disposable tips are cleaned by picking up and dispensing water from a fresh beaker of deionized water immediately before use. Adjustable pipettes are calibrated gravimetrically using an analytical balance. The density of water at 20°C is 0.9982 gram per cubic centimeter (g/cc). A chart is available for calibrating at different temperatures. Five aliquots should give a reasonable indication of precision and accuracy.

Use the following procedure to prepare the combined intermediate standard [20.0 mg/L of nitrate as nitrogen (NO_3^--N) and 100.0 mg/L of sulfate (SO_4^{-2})]: Combine 2.0 mL of NO_3^- stock solution and 10.0 mL of SO_4^{-2}) stock solution, and dilute to 100 mL. Prepare intermediate standards monthly, and store at 4°C.

Prepare the working calibration standards using the following dilution scheme, and store at 4°C.

Standard	Concentration (mg/L) NO_3^--N	SO_4^{-2}	Milliliters of Combined Intermediate Standard Diluted to 100 mL
1	2.0	10.0	10.0
2	1.0	5.0	5.0
3	0.6	3.0	3.0
4	0.3	1.5	1.5
5	0.1	0.5	0.5
6	0.04	0.2	0.2
7	0.008	0.04	0.4 mL of Std 1

4.3.4 SAMPLE ANALYSIS

Use the following procedure to analyze samples:

1. Samples containing particulate matter should be filtered. Particulate matter can deposit on the guard column bed support, resulting in increased back pressure and causing leaks. Sample vials contain a 20-micrometer (um) frit which is adequate for most samples. Filtration is performed automatically during operation of the autosampler.
2. Load the integration method from disk into the system computer as follows:
    a. Turn on the Multitech® power switch on rear of computer.
    b. At the prompt, type MAX to load the Maxima® integration program.
    c. Using the mouse, pull down the Methods menu and click on the Load Method option.
    d. Load the appropriate method (Teflon® , nylon, or Whatman).
    e. Pull down the Methods menu and click on the Execute Current Method option.
    f. Click on the Start option, and begin the ion chromatography run by pushing the START pushbutton on the AutoIon® Controller.

    NOTE: After the standard curve runs to completion, pause the run to review the standard curves before proceeding with the run.

3. Inject the lowest working calibration standard. Review the chromatogram and adjust peak detection parameters to detect analytes, if necessary.
4. Load the sampler with standards, from high to low, including a blank. Add an NBS reference sample and a midlevel control sample. Continue by loading samples, including a midlevel control standard, after every tenth sample and at the end of the

analytical run to assure the integrity of the run. An NBS reference sample is also placed at the end of the run.

5. With the controller and integration computer programmed correctly (refer to the instrument manual), press START and switch the conductivity detector from local to remote.

4.3.5 ION CHROMATOGRAPH SHUTDOWN

Use the following procedure to shut down the ion chromatograph:

1. Press RESET.
2. Turn off the conductivity cell.
3. Turn off the helium tank.

4.4 QUALITY CONTROL

4.4.1 REPLACEMENT OF COLUMN

The separator column is never in a static state; there is a steady decrease in active sites on the resin bed proportional to the column's use and age. Periodic cleaning or replacement of the guard column minimizes separator column degradation due to inorganic or organic contaminants, but the unavoidable effect of usage is a gradual loss of column capacity. When baseline separation between nitrate and bromide is no longer possible, the column must be replaced.

4.4.2 QC SAMPLES

The QC samples required with each sample lot are:

1. Analysis of a reference sample traceable to the National Bureau of Standards (NBS) to monitor accuracy,
2. Analysis of 10 percent blind replicates,
3. Periodic analysis of filter blanks,
4. Analysis of a control sample after every 10 samples to monitor precision (relative percent difference), and
5. Analysis of U.S. Environmental Protection Agency (USEPA) QC filters.

4.4.3 EVALUATING CURVE DATA

Curves with a quadratic fit correlation coefficient of <0.998 suggest an incorrect or contaminated standard. Remake and rerun standards as needed. Check Y-intercept and 95-percent confidence interval. When curve results are satisfactory, complete the run.

4.4.4 FINAL RESULTS

Enter the network CLASS system. Initiate Maxima® Autobatch Transfer program and respond to the computer prompts. After the raw data have been transferred to the CLASS system, the batch is completed by entering control spike targets, reference targets, and dilutions.

APPENDIX O

EPA METHOD 350.7 FOR THE MEASUREMENT OF AMMONIUM IN WET DEPOSTION SAMPLES BY AUTOANALYZER

8.0 EPA METHOD 350.7 FOR THE MEASUREMENT OF AMMONIUM IN WET DEPOSITION SAMPLES BY AUTOANALYZER®

8.1 SCOPE AND APPLICATION

EPA Method 350.7 is the reference method for measuring ammonium in wet deposition samples by automated colorimetric determination with phenate. This section presents a stepwise procedure for bench use by laboratory personnel.

This method was developed for the quantitative analysis of ammonium in rainwater. The applicable range is 0.01 to 1 milligram per liter (mg/L) of ammonium as nitrogen (NH_4^+-N). This range may be extended by sample dilution.

Turbidity and sample color absorbing in the wavelength range of 630 nanometers (nm) will present a positive bias. Since precipition samples are generally colorless and free of turbidity, this type of interference is rare and insignificant.

Contamination of samples with ammonia presents a far greater problem of positive interference. Ammonia is ubiquitous in the environment. Besides being respirated by the human body, ammoniated floor strippers and waxes are a serious problem and should be strictly prohibited.

Wash sample cups with deionized water immediately prior to use, and rinse cups again with a portion of the standard or sample to be analyzed. No more than 20 samples should be placed on the sample tray at the same time. Keeping a dust cover over tray during analysis will help eliminate ammonia contamination by restricting air flow.

8.2 EQUIPMENT AND MATERIALS

8.2.1 ANALYTICAL EQUIPMENT

The following analytical equipment is needed.

1. Sampler IV with a 40/hour, 4:1 cam.
2. Proportioning pump.
3. Analytical cartridge.
4. Heating bath [50 degrees Celsius (°C)].
5. Colorimeter with 630-nm filter and 50-millimeter (mm) flow cell.
6. Strip chart recorder.

8.2.2 INSTRUMENT CONFIGURATION

Glass transmission lines with an inside diameter of 1.5 mm should be used whenever possible. Glass lines last longer and produce better shaped peaks with less tailing than plastic tubing materials. Transmission lines should be kept to minimum length.

Use flow-rated polyethylene pump tubing. Before beginning the day's analysis, check for premature deformation and wear by rolling the tubing between the thumb and index finger. Change tubing after 50 hours of use; allow tubing to "break-in" with all reagents pumping through the system for 1 hour after changing.

Perform optical peaking of the colorimeter on a monthly basis according to the manufacturer's instructions.

8.2.3 REAGENTS

The following reagents are needed.

1. Sodium hydroxide (NaOH) solution, 10N:

   CAUTION: Use safety goggles, rubber gloves, and a laboratory apron.

   a. Place a heavy-duty 2-liter (L) beaker containing 500 milliliters (mL) of deionized water in a cool water bath.

b. Slowly add 400 grams (g) of NaOH, stirring continuously with a glass rod; allow to cool.

c. Pour solution into a 1-L flask, and dilute to volume with deionized water.

d. Store in a glass bottle with a Teflon® cap.

2. Alkaline phenol:

   a. Add 80 mL of 10N NaOH solution and 85 mL of 89-percent phenol solution to 250 mL of deionized water.

   b. Cool, and then dilute to 500 mL with deionized water. Store in an amber glass bottle. Prepare fresh weekly.

3. Complexing reagent:

   a. Disslove 33 g of potassium sodium tartrate ($KNaC_4H_4O_6 \cdot 4H_2O$) and 24 g of sodium citrate ($\{[HOC(COONa)] \cdot [CH_2(COONa)_2 \cdot 2H_2O]\}$) in 950 mL of deionized water.

   b. Adjust the pH to 5.0 with 2.5 mL of concentrated sulfuric acid (H_2SO_4).

   c. Dilute to 1 L with deionized water.

   d. Add 0.25 mL of BRIG-35.

4. Sodium hypochlorite (NaOCl) solution:

   a. Dilute 250 mL of a bleach solution containing 5.25-percent NaOCl (such as Clorox®) to 500 mL with deionized water. Available chlorine level should approximate 2 to 3 percent. Since Clorox® is a proprietary product, its formulation is subject to change. The analyst must be alert to detecting any product variation that would be significant to its use in this procedure. Due to the instability of this product, storage over an extended period should be avoided. Commercially prepared hypochlorite solutions frequently contain greater contamination than Clorox®.

5. Sodium nitroprusside [$Na_2Fe(CN)_5NO \cdot 2H_2O$] (0.05-percent):
    a. Disslove 0.5 g of sodium nitroprusside in 1 L of deionozed water.
    b. Add 0.25 mL of BRIG-35.

6. Sampler rinse water: add 0.5 mL of BRIG-35 to 1 L of deionized water.

8.2.4 CALIBRATION STANDARDS

Prepare the following calibration standards:

1. Stock Solution, 1,000 mg/L of NH_4^+-N:
    a. Dissolve 3.819 g of anhydrous ammonium chloride (NH_4Cl), dried at 105°C, in deionized water and dilute to 1,000 mL.
    b. Store stock solution in a glass bottle under refrigeration, and remake every 6 months.
    c. Using a reagent from a different lot, prepare an identical stock for use as control.

2. Standard Solution: Dilute 1.0 mL of stock solution to 100 mL with deionized water [1.0 mL = 0.01 milligram (mg) of NH_4^+-N].

3. Working Standard Curve: Prepare the working calibration standards according to the following dilution scheme:

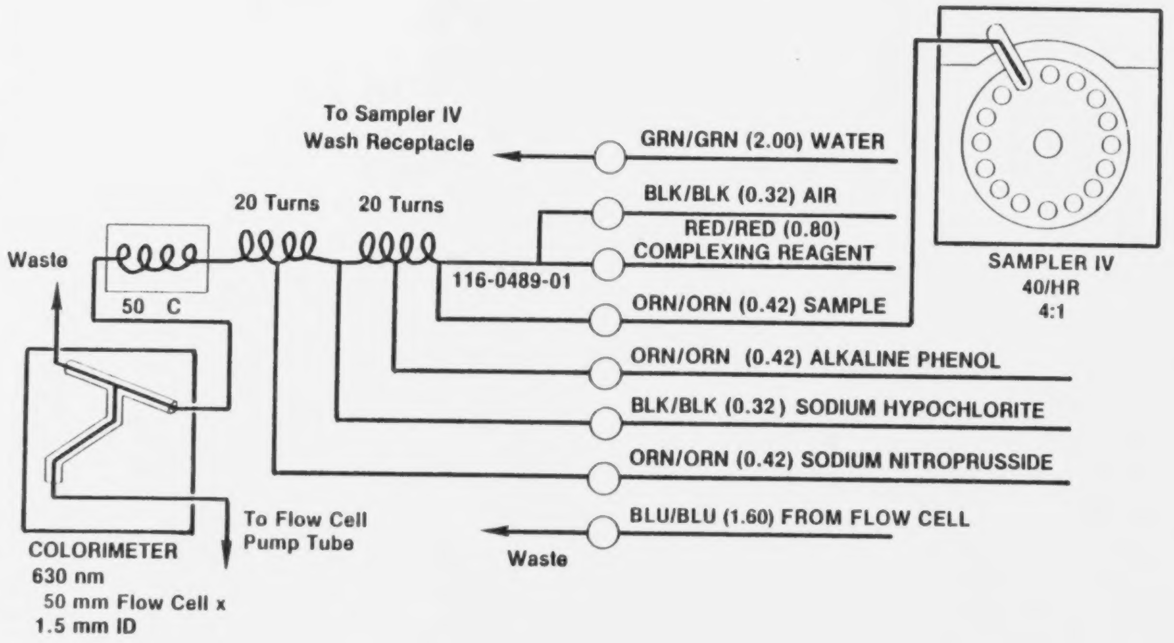
Working Calibration Standard Concentration (mg/L of NH_4^+-N)	Milliliters of Intermediate Standard Diluted to 100 mL With Deionized Water
0.01	1.0
0.02	2.0
0.10	10.0
0.25	25.0
0.50	50.0

A properly calibrated automatic pipetter with disposable tips is preferred over glass Class A pipettes. Ammonium contamination is difficult to eliminate when using glass pipettes with rubber suction bulbs. Keep a fresh beaker of deionized water to pick up and dispense water to clean tips. Clean volumetric flasks and stoppers are also rinsed with deionized water immediately before use. Standards can be stored for 5 days in polyethylene bottles under refrigeration. Use repeatedly the same labeled containers to store standards. Every month, shake 5 to 10 mL of 3-percent hydrogen peroxide (H_2O_2) in empty standard containers to kill bacteria, and rinse well with deionized water.

8.3 ANALYSIS

Use the following steps to analyze samples.

1. Set up manifold as shown in Figure 8-1.
2. The colorimeter and recorder should be on 30 minutes before proceeding. Except for maintenance and repair, the colorimeter and recorder should remain on at all times.
3. Pump deionized water through entire system for 20 minutes. After the first 5 to 10 minutes, sample a cup of 3-percent H_2O_2 to clean the lines of interfering bacteria which can accumulate in the sample line and attenuate low-level response to ammonium and also cause baseline noise.
4. With standard calibration set at 050, set the baseline of the chart recorder to 0.
5. Switch from deionized water to reagents. Allow the system to equilibrate for 30 minutes, and then record reagent baseline shift. A chart deflection greater than 10 percent of full scale


To Sampler IV
Wash Receptacle
GRN/GRN (2.00) WATER
BLK/BLK (0.32) AIR
RED/RED (0.80)
COMPLEXING REAGENT
ORN/ORN (0.42) SAMPLE
ORN/ORN (0.42) ALKALINE PHENOL
BLK/BLK (0.32) SODIUM HYPOCHLORITE
ORN/ORN (0.42) SODIUM NITROPRUSSIDE
BLU/BLU (1.60) FROM FLOW CELL
Waste
SAMPLER IV
40/HR
4:1
20 Turns
20 Turns
116-0489-01
Waste
50 C
COLORIMETER
630 nm
50 mm Flow Cell x
1.5 mm ID
To Flow Cell
Pump Tube

NDDN LAB 4/87

Figure 8-1
AMMONIA MANIFOLD CONNECTION DIAGRAM

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Environmental Protection Agency

National Dry Deposition Network

shows either reagent contamination or alkaline phenol deterioration (or both).

6. Standardize the instrument by setting the chart recorder response to 90 percent of full scale using the 1.00-mg/L NH_4^+-N standard.
7. Run standard curve, control standards, and reference samples traceable to the National Bureau of Standards (NBS). Compute correlation coefficient and percent recovery for controls and reference sample before proceeding with samples.
8. At the end of the run, switch all lines to deionized water and rinse the system for 20 minutes.
9. Calculate the ammonium concentration of the unknown samples by comparing the chart response of the samples to a quadratic regression line generated from the responses of the working standards.

8.4 QUALITY CONTROL

The QC samples required with each sample lot are:

1. Analysis of NBS-traceable reference samples to assess accuracy.
2. Analysis of 5 percent of the spikes and duplicates, with at least one sample reanalyzed from a previous lot.
3. Periodic analysis of bucket liner blanks.
4. Analysis of a midrange standard at least every 10 samples to assess precision.

APPENDIX P

ACRONYMS AND ABBREVIATIONS

ACRONYMS AND ABBREVIATIONS

ACID MODES - Acid model operational diagnostic evaluation study
ADOM - Acid deposition and oxidant model
ADS - Acid deposition system
Al - Aluminum
AMPS - Amperes
°C - Degree Celsius
Ca_{+2} - Calcium
CAL - Central analytical laboratory
Cd - Cadmium
Cl^- - Chloride
Cu - Copper
DAS - Data acquisition system
° - Degree
ΔT - Delta temperature
EEPROM - Electronically erasable programmable read-only memory
EPA - U.S. Environmental Protection Agency
ESE - Environmental Science and Engineering, Inc.
F^- - Fluoride
Fe - Iron
FRP - Forest Response Research Program
ft - Foot
g - Gram
g/L - Grams per liter
hp - Horsepower
H_2O - Water
H_2O_2 - Hydrogen peroxide
H_2SO_4 - Sulfuric acid
HNO_3 - Nitric acid
IC - Ion chromatography
ICP - Inductively coupled plasma
I.D. - Identification
K^+ - Potassium
Km - Kilometer
K_2CO_3 - Potassium carbonate
Lpm - Liters per minute
L - Liter
LIS - Low ionic strength
M - Meter
m^3 - Cubic meter
MCCP - Mountain Cloud Chemistry Project
Met - Meteorological
MFC - Mass flow controller
Mg^{+2} - Magnesium

Mg - Milligram
µg - Microgram
Mg/L - Milligram per liter
µg/mL - Microgram per milliliter
mm - Millimeter
Na^+ - Sodium
NADP - National Atmospheric Deposition Program
NaOH - Sodium hydroxide
NAPAP - National Acid Precipitation Assessment Program
NBS - National Bureau of Standards
NDDN - National Dry Deposition Network
NH_3 - Ammonia
NH_4^+ - Ammonium
NH_4NO_3 - Ammonium nitrate
NO_2^- - Nitrite
NO_3^- - Nitrate
NO_x - Nitrogen oxide
NTN - National Tends Network
OEN - Operation Evaluation Network
O&M - Operation and Maintenance Manual for Precipitation Measurement Systems
O_3 - Ozone
Pb - Lead
PC - Personal computer
% - Percent
ppb - Parts per billion
ppm - Parts per million
psi - Pounds per square inch
QA - Quality assurance
QAPP - Quality Assurance Project Plan
QC - Quality control
RH - Relative humidity
RADM - Regional Acid Deposition Model
rpm - Revolution per minute
SCS - U.S. Soil Conservation Service
SLPM - Standard liters per minute
SO_4^{-2} - Sulfate
SOP - Standard Operating Procedure
SO_2 - Sulfur dioxide
T - Temperature
TEA - Triethanolamine
TFR - Transition flow reactor
USEPA - U.S. Environmental Protection Agency
USFS - U.S. Forest Service
USGS - U.S. Geological Survey
w/m^2 - Watts per square meter

APPENDIX Q

GLOSSARY

GLOSSARY

The following list of terms are directly related to acid deposition and monitoring. In some cases the definitions are not exact, but are written to enhance understanding and practical use. Definitions for the following terms came from the resources listed below.

1. Glossary of Environmental Terms. U.S. Environmental Protection Agency, OPA-87-017 (March 1988).
2. The National Acid Precipitation Assessment Program (NAPAP) Interim Assessment of the Causes and Effects of Acidic Deposition, Volume I Executive Summary (September 1987).
3. NDDN Training Manual for Site Operators (June 1987 Draft).
4. Proceedings: Methods for Acidic Deposition Measurement. U.S. Environmental Protection Agency, U.S. Geological Survey and Electric Power Research Institute. EPRI EA-4663 (August 1986).

Acid Deposition. A complex chemical and atmospheric phenomenon that occurs when emissions of sulfur and nitrogen compounds and other substances are transformed by chemical processes in the atmosphere and then deposited on earth in either a wet or dry form. The wet forms, popularly called "acid rain," can fall as rain, snow, or fog. The dry forms are acidic gases or particulates.

Acidic Deposition Precursor. A material such as SO_2 or NO_x which is transformed to become a component of acid deposition.

Airborne Particulates. Total suspended particulate matter found in the atmosphere as solid particles or liquid droplets. Chemical composition of particulates varies widely, depending on location and time of year. Airborne particulates include: windblown dust, emissions from industrial processees, smoke from the burning of wood and coal, and the exhaust of motor vehicles.

Air Pollutant. Any substance in air which could, if in high enough concentration, harm man, other animals, vegetation, or material. Pollutants may include almost any natural or artificial composition of matter capable of being airborne. They may be in the form of solid particles, liquid droplets, gases, or in combinations of these forms.

Ambient. The atmospheric conditions (air) at any given time. This would relate to physical properties such as humidity, barometric pressure, and temperature, as well as constituent properties such as air pollutants (e.g., ambient temperature).

Anemometer. An instrument used to measure windspeed that generally is mounted on a meteorological tower and connected to a data recording device.

Anthropogenic. From a human source.

Aspirated Shield. A metal housing containing an impeller motor that draws ambient air through at a constant rate. This air flow passes over a temperature probe fitted in the end opposite the motor. This continuous air flow assures constant temperature readings and immediate detection of temperature fluctuations. This device is an integral part of a temperature-monitoring system.

Atmospheric Dump. A tubing configuration for ambient monitoring that allows test gases to vent to the outside atmosphere. This prevents pressurization of the instrument which could cause internal damage and invalid responses.

Audit. A diagnostic field procedure in ambient air quality monitoring. Also see Performance Audit and Systems Audit.

Base Cations. Cations, such as calcium and magnesium, which can neutralize incoming acids.

Calibration. A technical procedure to determine if an instrument needs adjustment and/or to adjust an instrument so its responses are directly proportional to known and traceable inputs. A calibration is also used to validate previous data and to assure the operator that an instrument is operating properly.

Capillary (Critical Orifice). A solid glass tube which has a specified diameter hole through the center length used for regulating and controlling air flow in the pneumatic system of an air quality analyzer.

Charcoal Canister (Scrubber). A cylindrical container filled with charcoal and/or other pollutant removal/conversion materials. The internal material actually "scrubs" the pollutants from an airstream.

Confidence Interval (95%). A range of values that have a 95 percent chance of being within the true value of the population parameter of interest.

Cross Arm. A T-structure which holds meteorological sensors and is mounted on a vertical tower.

Data Acquisition System (DAS). A digital electronic device which receives electrical signals from an air quality analyzer and integrates and converts the signals into digital data. These data are then stored and/or transmitted to a data recording device.

Density Transducer. A detection device in an ozone analyzer used to determine a ratio of barometric pressure and temperature to facilitate correction in flow rates.

Deposition Velocity. A ratio of dry deposition rates to air concentrations, useful in estimating dry deposition when only air concentrations are known.

Dew Point. The temperature of ambient air at which its water vapor would attain its maximum point of saturation and change into a liquid.

Diurnal Variations. Daily patterns of change, e.g., surface pollutant concentrations as influenced by atmospheric processes and emissions.

Dry Deposition. Removal of trace gases and particles from the atmosphere through interactions with various surfaces.

Ecological Impact. The effect that a man-made or natural activity has on living organisms and their non-living (abiotic) environment.

Ecology. The relationship of living things to one another and their environment, or the study of such relationships.

Ecosystem. The interacting system of a biological community and its non-living environmental surroundings.

Exceedance. (1) A going beyond the proper limits of; (2) violation of environmental protection standards by exceeding allowable limits or concentration levels.

Fick's Law. The law that relates fluxes to gradients in concentration, which is important in dry deposition.

Filter Pack. A group of sequentially-placed filters through which air is sampled at a measured, or otherwise carefully controlled, constant rate. Ideally, each filter should selectively capture and retain a different pollutant from the mixture of pollutants in the air.

Filter Screen. A multilayer metal screening material used to filter incoming room air in an air quality analyzer. This screen is located near a pump intake.

Flux. The rate at which material passes through a unit area expressed as mass per unit area per unit time.

Fugitive Emissions. Air pollutants arising from human activities, such as roadway and industrial dust, that do not emanate from a particular point, such as an exhaust pipe or stack, and are not readily amenable to control.

Greenhouse Effect. The warming of the Earth's atmosphere caused by a build-up of carbon doxide or other trace gases; it is believed by many scientists that this build-up allows light from the sun's rays to heat the Earth but prevents a counterbalancing loss of heat.

Hectare (ha). A unit of surface area equal to 2.47 acres or ten thousand square meters.

Hydrocarbons (HC). Organic compounds containing only carbon and hydrogen, e.g., methane and ethylene.

Hydrometeors. Water particles in the atmosphere (rain, snow, sleet, hail, etc.).

Inferential Method. A technique for estimating deposition velocities.

Initialization. The physical process of introducing commands and programming into a DAS.

Inlet Filter. A circular filter usually made of Teflon® (nonreactive) used to remove particulate matter from an incoming airstream. This filter is mounted in a housing and is placed on the sample port of an air quality analyzer.

Inversion (Inversion Layer). The phenomenon of a layer of cool air trapped by an upper layer of warmer air so that the bottom layer cannot rise and mix as usual. This is a special meteorological condition that often causes an unhealthy situation because air pollutants are trapped and concentrated near the earth's surface. An inversion layer can be mechanically detected by an instrument called an acoustic sounder.

Kriging. An interpolation technique used to form a regular rectangular grid of values from randomly spaced sites on a map.

Linear Response. A constant proportional change in one variable as another variable changes.

Mainframe. A meteorological instrumentation panel which contains the wiring and electronic components that receive, interpret, and display data from meteorological sensors.

Manifold. A structure, usually made of an inert material, through which air flow is passed and directed to or from an air quality analyzer.

Mass Flow Controller (MFC). An electronic flow controlling device. The device controls flow rate by mass and corrects to standard conditions of pressure and temperature within any volume of air.

Mass Flowmeter (MFM). An electronic flow-sensing device which responds in a linear fashion to the mass of air flow instead of just the physical passage of air. The device senses flow rate by mass and corrects to standard conditions of pressure and temperature within any volume of air.

Microenvironment. The environment near a small area of a much larger surface.

Micrometeorology. The science describing the interaction between the air and surfaces, whose spacial scale is less than one kilometer.

Microprocessor. The control and processing portion of a small computer. It serves as a processor for executing instructions and storing data and acts as an interface unit through which data and instructions are transmitted.

Mixing Chamber. A structure made of an inert material for mixing of gases.

Mixing Depth/Height. The expanse in which air rises from the earth and mixes with the air above it until it meets air equal or warmer in temperature.

Modeling. A investigative technique using a mathematical or physical representation of a system or theory that accounts for all or some of its known properties. Models are often used to test the effect of changes of system components on the overall performance of the system.

Modem. A telephone line to a computer or microprocessor to transmit data or to receive command instructions.

Multiple Linear Regression. A statistical technique which mathematically relates multiple independent variables to a single dependent variable.

National Ambient Air Quality Standards (NAAQS). United States standards which set the maximum level for several pollutants. There are two types: primary standards, which are set to protect human health, and secondary standards, which are set to protect public welfare (e.g., plants, animals, buildings, and aesthetics) in addition to human health.

Non-Point Source. Pollution sources which are diffuse and do not have a single point of origin or are not introduced into a receiving stream from a specific outlet. The pollutants are generally carried off the land by stormwater runoff. The commonly used categories for non-point sources are: agriculture, forestry, urban, mining, construction, dams and channels, land disposal, and saltwater intrusion.

Oxidation. A chemical reaction in which a compound or radical loses electrons; that is, in which positive valence is increased. For example, the oxidation of sulfur from SO_2 [S^{4+}] to $SO_4^{=}$ [S^{6+}], or the rusting of iron (Fe [Fe with no charge] to Fe_2O_3 -- Fe^{3+}).

Ozonator. A device in an O_3 monitoring instrument which generates O_3 in controllable known quantities.

Ozone (O_3). Found in two layers of the atmosphere, the stratosphere and the troposphere. In the stratosphere (the atmospheric layer beginning 7 to 10 miles above the earth's surface), ozone is a form of oxygen found naturally which provides a protective layer shielding the earth from ultraviolet radiation's harmful health effects on humans and the environment. In the troposphere (the layer extending up 7 to 10 miles from the earth's surface), ozone is a chemical oxidant and major component of photochemical smog. Ozone can seriously affect the human respiratory system and is one of the most prevalent and widespread of all the criteria pollutants for which the Clean Air Act required EPA to set standards.

Passivation. Saturation or conditioning of a pneumatic system before use (e.g., to saturate all tubing from a calibrator with SO_2 gas before use). This saturation assures the user that there are no residual contaminants in the lines that would interfere with or alter generation of a know concentration of test gas.

Performance Audit. A technical procedure used to assess the performance of both the air monitoring or analytical instruments onsite and the operator. Performance audits quantitatively assess data and measurement techniques under normal operating conditions without any special preparation or adjustment of the system.

Photochemical Oxidants. The substances produced when hydrocarbons and nitrogen oxides chemically react with the oxygen in the air in the presence of light (a primary photochemical oxidant is O_3). These also cause smog, eye irritation, and chest discomfort.

Photometer. An instrument for measuring the intensity of a light source by comparison with a standard (reference) light source. It is used in air monitoring to determine O_3 concentrations by a process called UV photometry.

Point Source. A stationary location or fixed facility from which pollutants are discharged or emitted. Also, any single identifiable source of pollution, e.g., a pipe, ditch, ship, ore pit, factory smokestack.

Precision Check. An operational check on an air quality analyzer in which its response to low-concentration test gases is tested. The normal precision check concentration is 0.090 ppm. The term precision is the key as its definition is actually repeatability of response to the same input.

Prevention of Significant Deterioration (PSD). A provision of the Clean Air Act (CCA), as amended in 1977, which protects air that is already good (i.e., pollutant levels are below the NAAQS) by strictly regulating the amount of additional pollution that can be emitted by new sources.

Primary Standards. The levels of air pollution below which there will be no adverse health effects on humans (a margin of safety is included).

Quality Assurance. All activities performed to control, assess, and assure the quality of data obtained from the measurement process (e.g., quality control, quality audits, document control, procurement control, quality objectives, and data validation).

Quality Auditing. Tests, checks, inspections, etc., performed by persons not involved in the measurement process. These tests are done to assure: (1) the QC checks specified in the procedures used in the measurement process are being done in a timely manner and in conformance with the SOP; (2) to assure that data of defined quality meeting the objectives (needs) of the project is being generated.

Quality Control. Routine checks, tests, inspections, etc., included in the measurement procedure that are carried out by those actually involved in the measurement process to ensure that data of defined quality meeting the project's needs is being generated.

Ramp. A short-time duration during which an air quality instrument is warming up and/or going through any self-diagnostics or preparation before reaching full operational status.

Scrubber (Charcoal Canister). A container filled with a medium for removing contaminants from an airstream, such as in a zero air system.

Sigma Theta ($\Sigma\theta$). Wind direction variance.

Span Check. An upper-level operational check to determine an analyzer's response to test gases.

Standard Operating Procedure (SOP) Manual. A step-by-step procedural manual for operation of an ambient air quality monitoring network.

Statistically Significant. A mathematical finding that a null hypothesis (e.g., that two populations have the same median) can be rejected with some specified level of confidence.

Strong Acid. An acid such as sulfuric or nitric which tends to completely dissociate resulting in greater acidity (or lower pH) than an equivalent amount of weak acid.

Synergistic. A situation in which the interaction of discrete agents is such that the total effect is greater than the sum of the individual effects.

Systems Audit. A procedure used to qualitatively assess data collection and administrative procedures independently of the total measurement system, entailing onsite inspection and review of recommended or imposed regulatory procedures.

Throughfall. The combination of precipitation that falls directly through the canopy without being intercepted and that which is intercepted but drips off the canopy directly to the ground.

Time of Wetness. The period of time that a material surface is wet, generally expressed as a percentage of the time during a day.

Transfer Standard. An instrument or component in a monitoring system that has been certified against a known, primary standard and is used in the field for testing other analyzers (e.g., O_3 transfer standard).

Uncertainty. The sum of systematic and random errors associated with an estimate.

Weak Acid. An acid such as carbonic or humic acid which tends to dissolve incompletely and thereby produces less acidity than an equivalent amount of a strong acid.

Zero Air. Air free of any contaminants that would interfere with or bias an air quality measurement. Zero air is used for dilution and calibration of air monitors.